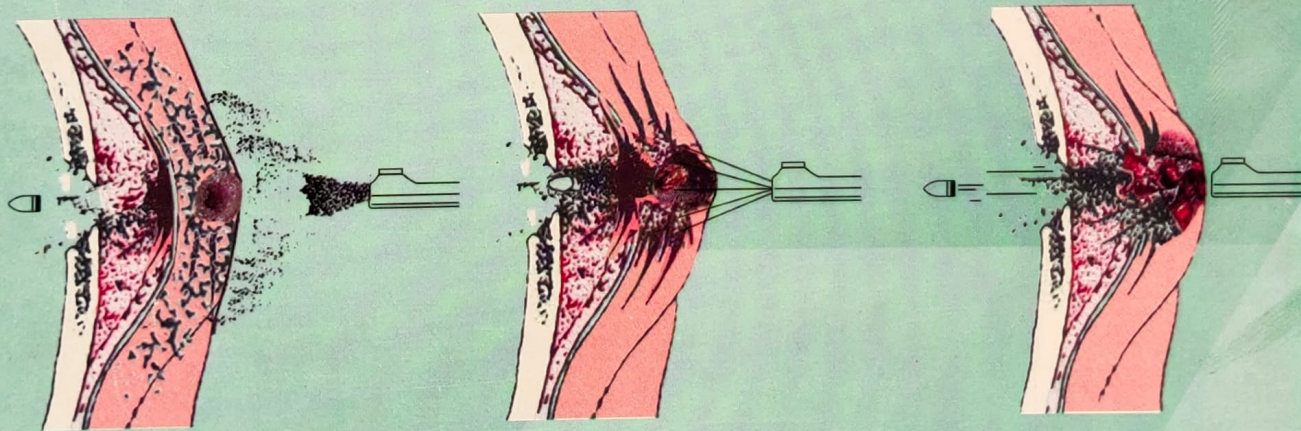


Second Edition

Principles & Practice of Forensic Medicine



Nasib R. Awan

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**Principles & Practice
of
Forensic Medicine**

2400

Principles and Practice of Forensic Medicine

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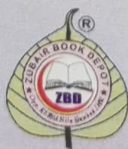
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Dedication

**This work is dedicated to
the two most influential individuals in my life**

**To my father
SUFI ABDUL AZIZ
Who set me on the difficult path to truth**

**And to my wife
ALMAS KHANUM
Who walked that path with me**

Acknowledgements

1st Edition 2004

Only with the blessing of Almighty Allah have I been able to complete this work. It was my wife, Dr. Almas Nasib, who pushed me to take to pen and put down on paper the knowledge and experience I had gained while working in Forensic Medicine in Pakistan.

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In the end, many thanks are due to Mr. Muhammad Sohail Kanwar of the Sublime Arts, for bearing with my insistence on doing things my way.

2nd Edition 2018

Almighty Allah graciously granted me strength and courage to complete the second edition of the book in four-color print in spite of my weak health after coronary by-pass surgery. I was initially reluctant to start work on this revised edition anticipating difficulties in continuing research and arranging colored photographic material after retirement. My son Nasir Raza Awan impressed upon its necessity in this revised edition and the benefit it would give to the reader, especially the medical students. His motivation was the stimulus needed to get me going.

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Last of all, I acknowledge the help Mr. Khubaib Ahmad extended in publication of this book and Mr. Imran Bhatti for book title design.

Nasib R. Awan

Preface

Medical knowledge is expanding with tremendous speed. Quantum of knowledge of many medical subjects is increasing and new subspecialties are emerging fast. Specialists of various disciplines regard their own subject as deserving special attention. This has blurred previous definitions of medical specialties. Consequently, the modern medical student is stuffed with more knowledge than his predecessors and tends to get fatigued. He finds himself inadequate to adjust to this challenge and takes his studies superficially, with the result that emphasis that is due gets shifted elsewhere. Prevailing confusing and conflicting concepts about subjects and their merging boundaries into each other have further complicated the situation. This has not occurred without repercussions, the subject of Forensic Medicine being the most affected. The decline in the standard of Forensic Medicine in our country is quite clearly visible. The proof of this is the hue and cry raised in the media almost daily against the medical profession, especially as far as their dealing of the medico legal cases is concerned, for example, autopsy, medical reporting, certification and unethical behavior. These are the very areas that fall in the purview of Forensic Medicine.

In our present medico legal set up, the medical officer's position is that of a keystone. He is the one to perform all sorts of medico-legal examinations including autopsy, carry out medico-legal investigations, prepare medico-legal record and finally issue a report or a certificate. He, in fact, has to do a lot of medico legal work. Things may go wrong when he is caught unaware, especially when he finds himself lacking in skill as well as in knowledge to do his job. This is the result of his inadequate training in the subject. Then troubles pile up. Not only does he become a target of public anger and media's criticism but also brings a bad name to the whole profession. This has to be remedied. The situation demands that Forensic Medicine is viewed in its proper perspective and required impetus is given to its training.

Law and medicine have been interrelated and interdependent since antiquity. There are two important facets of this relationship, the legal aspects of medicine and the medical aspects of law. The legal aspects of medicine known as medical jurisprudence deal with the impact of law on medical practice. It is imperative for

the medical man to know laws that are relevant to his profession to understand his position in relation to the state, patient, colleagues and others, so that he practices his profession according to legal dictates. Knowledge of law makes him a better medical practitioner and a better citizen and safeguards both his interests and the interests of the public.

Medical aspects of law known as forensic medicine involve application of medical knowledge to resolve legal issues. Here medicine comes to the rescue of law. To this aspect, there are two prerequisites, which are complementary to each other. One is the basic medical knowledge imparted by specialists and the second, the skill to apply that knowledge to solve legal problems. This skill is acquired during training in the subject of Forensic Medicine.

It is understandable that both these two facets of law- medicine relationship are important, inseparable from and complementary to each other. In the face of increase in crimes of murder, sexual assaults, transportation and industrial accidents and increasing awareness of public about their rights, compensation claims against medical malpractice or negligence, the importance of Forensic Medicine is only enhanced. This aspect of the relationship must also be realized that both medicine and law are progressive disciplines and both aspire to serve the humanity. Although medicine and law share certain common grounds, they also differ in many respects. Medicine aims at preventing and healing disease including trauma whether physical, chemical or psychological. Law is interested in its causation and the outcome. Here the two disciplines do not look face to face at each other. This basic philosophy must be understood,

This book is an attempt to answer some of the questions. If the student takes a fresh look at the subject, the medical officer feels confident in facing the court, and the medico legal problems no more remain his bet noire, the book has served its purpose.

Nasib R. Awan

Lahore, Pakistan

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1. Forensic Medicine

System of selecting a subject for professional medical practice after basic medical qualification did not exist during earliest period, because quantum of medical knowledge was limited and also public was not conscious about health and their rights. It was an era of simple medical graduates. He was responsible for all the needs of his patient i.e. medical examination prescribing/applying medicine, investigating illness if required and issuing medical certificate of health status for administrative purposes. Separate prescribed teaching syllabus of under-graduates of medicine and dentistry is modern concept and there are now many subjects, each having an epithet (name) for its recognitions.

Naming subject started during the course of medical practice, when medical knowledge was extremely limited and only one mother subject by the name "*medicine*" selected for all patient's needs. After passage of reasonable time along with improvement in understanding of medical treatment and also appreciation of difference skills of application of medical treatment, a second mother subject by the name "*surgery*" got introduced. Further on at the various stages of advancement of medical knowledge about vital body systems and individual body organs, which continued to expand and properly understood, there arose the necessity of re-allocation of medical knowledge into separate and manageable compartments to grant them new epithets for each like "*Cardio-vascular medicine/surgery*" and "*Ophthalmology*". Subjects have also been created and named uniting knowledge of two allied or related subjects adding adjective to one of them to identify their relationship like "*Pediatric medicine/surgery*" and "*Forensic medicine*".

Besides naming another change in medical practice that has taking place is that initially all patient's needs were the responsibility of medical practitioner holding basic medical qualification. He was all powerful. Specialization in specific subjects has completely revolutionized the situation. Defined specialists have come to take care of patients' needs. Now we have treating physician, operating surgeon, investigating pathologist/radiologist and certifying medical examiner who hold specific medical qualification; in addition to basic medical

qualification. Standard of provision of medical treatment and certifications have much improved.

Forensic Medicine, also alternately called **Medical Jurisprudence** is the granted epithet. Forensic is for *Law*, Jurisprudence is for *philosophy of Law* and their addition with word *medicine* constructs the name, also indicating relationship between both subjects i.e. law and medicine. Both epithets are now considered synonymous and are interpreted to include identical matters. English and European named it as *forensic medicine* and *legal medicine* and Americans as *forensic pathology*.

Relationship of subject of Law and Medicine with administration of justice is very old, intimate and also unique. Both are learned and progressive since antiquity and have been serving human beings directly as "client" and "patient", but separately within confines of respective environment i.e. Law Chamber and Hospital. While in professional relationship, both specialize on the problems brought by client and patient and try to find solution or remedy after knowing truth, a "**common goal**". Achieving goal depends upon proper understanding of the problem, which some time may become difficult especially when it has arisen simultaneously from one experience. Example is a case of divorce in a court of law, where wife claims husband to be impotent and husband his wife suffering from veganism. It can easily be resolved by proper medical opinion/advice about state of health of both wife and husband. Both lawyer and medical practitioner thus should dependent on each other for sack of administration of justice. (Fig 1.1)

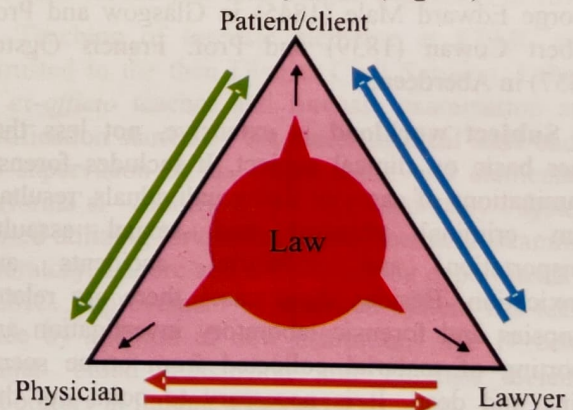


Fig 1.1: Law-Medicine relationship

As regards definition, importance and status of the subject of forensic medicine, it is defined as, **“a subject that deals with application of principles of medical knowledge to purposes of law and furthering of justice”**. Its importance is due to its public service necessity, which has since been acknowledged by law in connection with administration of justice. Status of forensic medicine in its own right as an independent subject of medical curriculum is because of exclusive prerogative of forensic certification, as no other branch of medicine teaches it. It is for this reason it has been included as

an essential and examination subject in syllabi of both Law and Medicine.

Graduates of both law and medicine learn this subject at their respective institutions and qualify university examinations to finally join professional practice. Rapid increase of knowledge in medicine is utilized by law enforcement agencies as well as courts of law to resolve complicated medico-legal issues. It has granted forensic medicine a pivotal position and it acts like a cross-road or bridge for interaction between both disciplines, where they update themselves. During professional life later, this relationship becomes unending. (Fig 1.2)

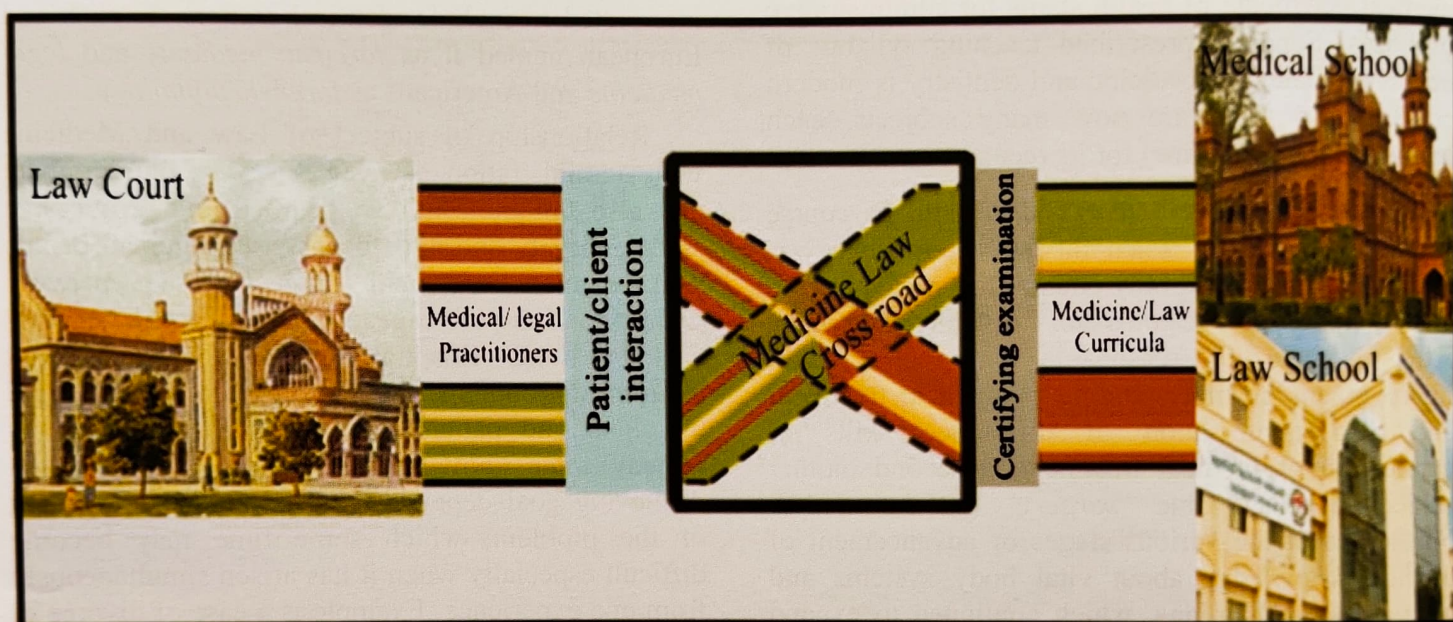


Fig 1.2: Law Medicine pathway

First Chair of Medical Jurisprudence and Medical Police was created with royal patronage in U.K. way back in 1807, followed by Prof. John Gordon Smith (1832). Other Chairs established later were Prof. George Edward Male (1845) in Glasgow and Prof. Robert Cowan (1839) and Prof. Francis Ogston (1857) in Aberdeen.

Subject workload is extensive, not less than other basic or clinical subject. It includes forensic examinations of cases of living individuals, resultant from criminal physical and sexual assaults, transportation and industrial accidents and intoxication. Besides these cases there are related autopsies and forensic laboratory investigation and reporting of material collected from crime scene, living and dead. It is necessary to point out that forensic examination and certification is a difficult

task of much higher responsibility than routine clinical examination, having its own specific approach, technique and procedure.

General belief about forensic medicine is merely a forensic aspect of medicine, requiring simple common sense for its interpretation is neither correct nor quite fit this pattern. Prof. Sidney Smith, University of Edinburgh (1928-1953) emphasized that medical knowledge and a stock of common sense are not sufficient themselves for understanding of medico-legal problems, which are presented to law enforcement agencies and law courts. They are of very specific nature and differ entirely from clinical cases with which practitioners of medicine have generally to deal with.

Comparing clinical practice with forensic medicine practice indicates that they differ in their

examination objectives. In medical practice, all facilities for medical treatment i.e. in and out-patients, investigating laboratory including radiology services are situated in the same building. Laboratory specimens are either sent to laboratory or technician from laboratory goes to the wards to collect them. Interest of both is same; to have results quickly with no chance of substitution except an error of labeling. In contrast, places for forensic examination including autopsy and collection of samples are situated miles apart from forensic laboratory. Further there are two opposing parties in a case and both desire and try to obtain forensic certificate in their favor. To achieve this objective, they may distort history of allegation and also make attempts to substitute or adulterate samples. Forensic Medical Examiner has to entertain *low threshold of suspicion*, while evaluating history of allegation, adopt necessary precautions during collection, packing and dispatch of samples to forensic laboratory and maintains *chain of custody* of forensic samples, following strictly legal dictates in this respect. (Table 1.1)

Table 1.1:**Legal dictates for forensic medical examination**

- Only authorized medical examiner to undertake forensic medical examination
- Expressed written consent of examinee, a prerequisite
- Verification of examinee's personal identity essential
- Who, how much and to whom fee of medical examination paid be recorded for transparency
- On whose behalf i.e. examinee's, police or law court forensic medical examination undertaken
- Choice of sampling, its collection, preservation and dispatch to laboratory undertaken by medical examiner him-self or at least under his personal supervision
- All required investigations documented in medical certificate
- Samples collected in impervious glass containers and sealed before dispatch*
- Ensures seals are intact at the time of receipt of samples in laboratory
- Before and after receipt samples kept in freezing temperature **
- Processing of sample undertaken in turn without delay
- Results of investigation sent back to examining forensic medical examiner by name under sealed cover

* To avoid addition or substitution

** To prevent decomposition of biological material and eventually negative results

Another point of difference is that forensic practice unlike clinical practice extends beyond hospital into the premises of Court of Law in continuation of forensic certification to help furthering of justice. Nature of duties performed in hospital and Court of Law though are equally responsible, yet different in concept. During later stage, Forensic Medical Examiner has to on oath *present, interpret, authenticate and even justify* all recorded findings and opinion already expressed in medical certificate as factual and true. There is no such thing in clinical practice.

Courses of studies in forensic medicine for medical undergraduates traditionally contained pathologic-anatomy and forensic-toxicology. Prof. John Gradwohl, while accepting them as firm pillars did not agree to such a narrow definition. He pointed out that forensic medical examinations are concerned with medico-legal issues that are referred and contained in prescribed laws dealing with offences against the person or brought before the court of law for decision. He stressed that knowledge of related legislation, administrative regulations as they impinge upon medicine and other related basic matters about law courts, legal procedure and court evidence are also necessary.

Teaching of forensic medicine and practice of forensic certification along with related laboratory investigations for purposes of enforcement of law were introduced in Indian-subcontinent by English much later after its colonization. They also brought allopathic medicine, educational and judicial system and laid foundation of Lahore Medical College, later named King Edward Medical College (KEMC) in 1860 and eleven year later Punjab University in 1871.

Teaching of forensic medicine at KEMC was entrusted to the then District Civil Surgeon, Lahore as *ex-officio* teacher and forensic examination and certification started by his junior medical staff under his supervision at his office using two elementary Performa's. Modified partial laboratory system started utilizing service at Punjab Chemical Examiner laboratory, Lahore and a few teaching departments at KEMC. Improvement of inherited system has taken place by addition of new institutions like Director, Punjab blood transfusion and Forensic Science Laboratory at Lahore. (Table 1.2)

Table 1.2:*Name of institutions, places and allocated work*

Name	Place	Allocated duty
<i>Services introduced by English</i>		
Punjab Chemical Examiner,	Lahore	Forensic Toxicology and semen analysis
Anatomist, Punjab government	Prof of Anatomy, K.E.	Forensic Anatomy
(Additional duty)	Medical College, Lahore	
Bacteriologist, Punjab government	Prof of Bacteriology, K.E.	Forensic Bacteriology
(Additional duty)	Medical College, Lahore	
Entomologist, Punjab government	Prof of Entomology College of	Forensic Entomology
(Additional duty)	Community Medicine, Lahore	
Serologist, Federal government	Karachi (now abolished)	Forensic Serology
<i>Services added after establishment of Pakistan</i>		
Director Punjab blood transfusion	Lahore	Forensic Serology
Director Punjab forensic science laboratory	Lahore	Forensic toxicology, semen analysis and DNA testing

Above systems continued even after partition till 1995, when first independent Department of Forensic Medicine staffed by qualified specialists and technically equipped was established at KEMC, Lahore. Now all public and private sector medical colleges have departments of forensic medicine.

Forensic medical certification is important public duty undertaken for administration of justice through law enforcement agencies including police and law courts. It is an essential duty linked with related police station and court jurisdiction. This duty can neither be referred to other medical facility without permission of higher authorities nor its examination delayed at authorized center. Transportation outside to other medical facility is even inadvisable, because of chances for loss of vital evidence during transit, call of nature, cleansing of parts especially in sexual assaults. Further findings in trauma cases with lapse of time get masked due to onset of repair or infection in the injured part and decomposition of the corpse.

All Provincial Governments in the country are duty bound to provide these services at public sector hospitals from Rural Health Center to Tehsil, District and Tertiary Teaching Hospital like provision of treatment facilities for medical, surgical and other patients. But facilities provided in public sector hospitals are substandard and inadequate. Medico-legal certification of living criminal trauma, intoxication, sexual assaults and related autopsies of dead are undertaken by most joiner general duty Medical Officers without specific training or qualification. Premises where work is undertaken lack basic logistics like examination/autopsy table, mortuary freezer for storing corpse and some places

especially in rural area or even without electricity and water supply.

Forensic medical certificate and its preparation are like issuing legal tender. It is a technical exercise requiring serial division of work for much detailer elucidation of findings during forensic examination, investigation, incorporation of results and additionally includes other related information surrounding the case. Findings both positive as well as negative should be documented for information of requesting forum i.e. administrative authority, law enforcement and law courts. Purpose of examination, on whose behalf it is performed and how much fee received are to be mentioned in the medical certificate for transparency.

Medical certificate should neither omit any finding nor include non-existent one. It is the most comprehensive document about state of health of the examinee whether healthy or diseased and is based exclusively upon medical facts observed during medical examination. Besides physical and mental status of examinee; other details such as description of worn clothes along with any change in them like torn or stained and other special characteristic such as trace evidence of hair in cloths are included in the medical certificate. Its preparation is both art and science requiring proper attention and concentration of mind. Medical procedures should be carried out with dignity, decorum and efficiency. Job requires neatness and precision and must reflect respect for human being, who may be a victim of physical aggression, sexual assault or even an accused and finally concluded with opinion of medical examiner at the time of examination. Beside, legal and moral considerations, duty may become arduous, while

examining decomposing dead and endangers safety of the workers.

Scope of forensic medical certification has not both been understood and appreciated, nor any worthwhile attention paid. It is adversely affecting administration of justice, which is an absolute necessity. What is recommended that architecturally-designed centers having **medico-legal clinic** for examination of living forensic cases, **forensic autopsy suite** for conduction of autopsies should be provided at medical facilities where such examinations are undertaken? Further, **laboratory system** at least one in each province for investigation of material collected from crime scene, living and dead victims should be established as centralized service.

Forensic laboratory examination is of diverse nature and requires elaborate services. Depending upon resources and expertise of country, two systems have been developed:

- **Full laboratory system**
- **Partial laboratory system**

Full laboratory system is superior to partial laboratory system being more efficient and provides services under one roof. Minimum divisions of moderate center are Forensic Biology, Toxicology and Histopathology. Highly developed center may have additional sections of Forensic Anatomy and Biochemistry. Further, there is additional advantage of coordination among specialists while certifying forensic findings in the consolidated form. Such an approach avoids both error and delay.

Partial laboratory system is rather an out dated concept, in which various working divisions are scattered in the province they serve.

Staff and equipment in both systems, of course, will depend upon type of services rendered, population served, crime index, proficiency standards, policy of storing of exhibits and general awareness of the public of their rights.

Building should have areas for registration and receipt of the specimens, stores for chemicals and reagents, technical working space for customized laboratory, library and offices of the staff, kitchen and utility services areas like toilets. Principle of design of building is that registration should be near the main entrance to facilitate receipt of specimens and other related information pertaining to the case without interfering with other sections. Unauthorized

public should be discouraged and not allowed entering. Location of stores and medical record should be away from the entrance and they should have window reinforced with iron bars. Their size would depend upon the workload and the policy of storing.

Security of facility and its arrangements are of paramount importance. First line of defense should include high boundary wall, complete absence of trees in the adjacent area of the buildings and other provision against fire. Second line of defense against theft is combination of strong bolts and unbreakable locking system.

Laboratory and instrument room should have adequate outside illumination and air conditioning should be efficient because modern instrument are more sensitive than personnel. Most of these equipment function in a very narrow range of humidity and temperature. Instrument room and chemical store should be placed away from each other to avoid contamination. Library, conference room and kitchen should also be located away from the working area. Placement of customized laboratories in relation to other services requires the advice of highly trained staff and the task is extremely technical.

Forensic examinations and related laboratory work in other countries are undertaken by trained and qualified staff. Forensic certification of living in England is done by qualified police surgeons. Forensic autopsies either performed by academic staff of Department of Forensic Medicine or designated pathologists of National Health Service at fully equipped judicial mortuaries. In Europe, especially France, Germany and Spain, medico-legal autopsies are conducted jointly by two specialty qualified experts under most favorable conditions. In U.S.A., forensic certifications are catered by qualified medical examiners at extensively equipped centers having additional legal authority to make spot investigation of circumstantial aspects of the case.

Prof. G. Forbes recommended merger of medico-legal certification and laboratory services and be located at Teaching Department of Forensic medicine in larger city. Arrangements should be developed to provide three major services besides teaching duties:

- Medico-legal Clinic
- Forensic Autopsy Suite
- Laboratory Services

Minimum essential support facilities for medico-legal clinic are forensic radiology, psychiatry and odontology. Laboratory services should cater for forensic anatomy, histopathology, toxicology and serology. Forensic autopsy suite essential services are freezers for storage of corpses, with a public viewing area. Additional facilities will be an exhibit museum, lecture rooms, public relation services and waiting area.

According to him, it will benefit all concerned. General public will have standard medico-legal certification provided by qualified manpower and also to the satisfaction of Law Courts. In return the teaching institution will have access to all categories of human teaching material so essential for teaching and training of both undergraduates and postgraduates and also for research. An additional benefit will be an appellant forum of senior and highly qualified staff. (Fig 1.3)

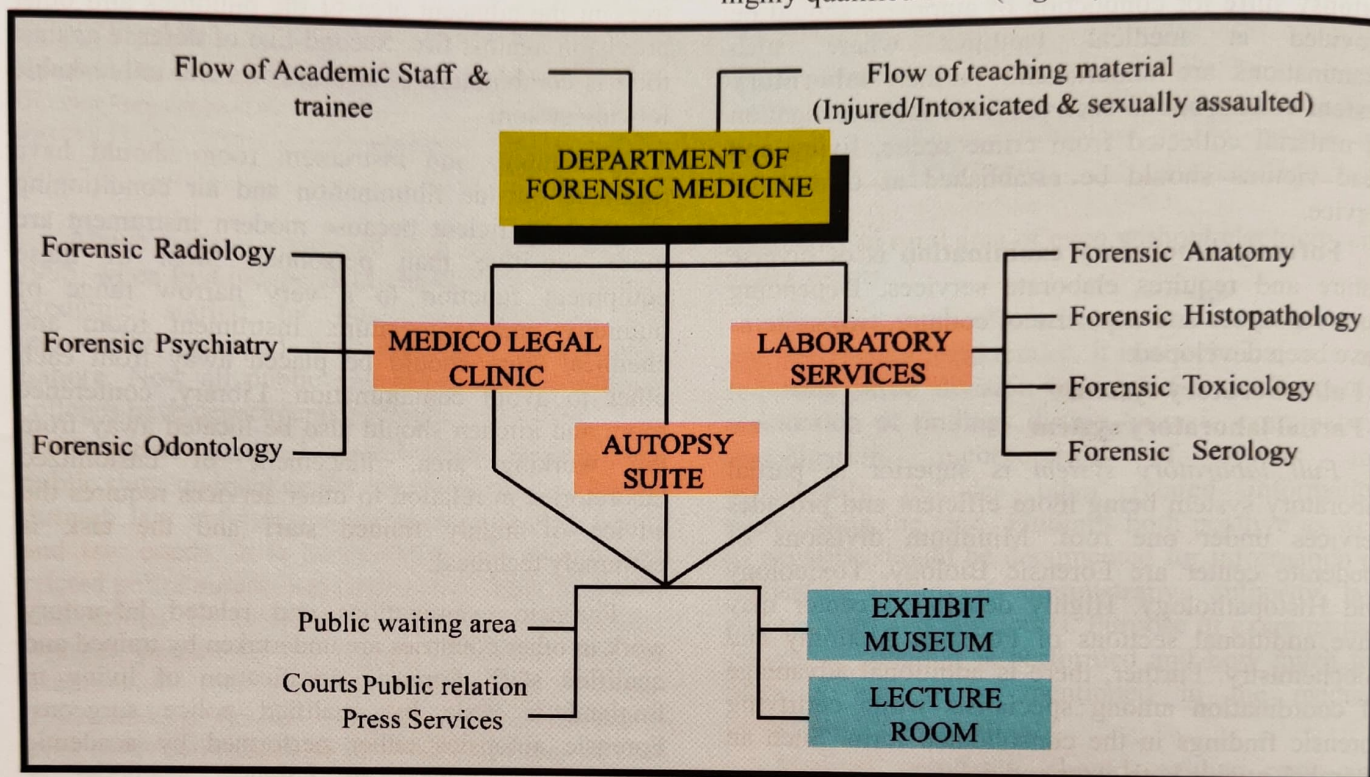


Fig 1.3: Facilities of Department of Forensic Medicine

2. Law, Courts of Law and Court Evidence

Law is an elusive term defying a comprehensive definition. In its broadest sense it means any rule of action and in this context it is applied indiscriminately to all kinds of actions whether animate or inanimate, rational or irrational. These range from scientific laws, rule of game, international laws ad infinitum. In a narrower sense and confined to human actions, however, it can be defined as a rule established by authority, society or custom based on reason as quoted, "*Law is nothing but reason and that what is not reason is not law*". Only those systems of laws, which pertain to humans, will briefly be described and discussed as we are limiting ourselves to the latter sense.

Sources and types of laws on the basis of its *sources* and *types* as applicable to human behavior are of two categories i.e. **common & statute law** and **civil & criminal law**.

Common law is an unwritten, generally accepted and applied system of law based on conduct decisions, usage and customs. The community in which we live controls conduct of an individual. Over centuries, therefore, a body of general and particular customs grew up which was and still is enforced by judges in the courts. The usefulness of common law is its universal applicability.

Statute law is body of law, which is enacted by the legislative body of a representative government or decreed by a ruler. In the former case it is known as an Act and in the latter an Ordinance. It is the written and the codified law of a country. The statute laws yield to changes introduced by amendments of legislature, decree of a military despot or foreign invader. Examples are that *English* after occupation of the Indian Subcontinent gave their laws and military despots introduced Ordinances like **Shariat Ordinances 1988**.

After enactment of the statute law, it is notified in Extra-Ordinary Gazette of the Government and later published in a booklet form. In its printed form, like any other book, it consists of a title, a preamble, parts, chapters, sections and schedule. A title, preamble and section are, however, the essential ingredients and form parts of every statute.

Civil law is that law, which deals with the rights of citizens in a particular state as distinguished from criminal law. It provides remedies for personal

grievances of individuals or group of individuals. It does not concern with the community as a whole. Issues arising from industry causing injury, intoxication or disease to worker, negligence during medical treatment causing damage to patient, matrimonial grievances of husband/wife and disputes between landlord/tenant are dealt under civil law. The damage to aggrieved party is compensated in terms of money.

Criminal law involves defining of crimes and laying their punishments. It exists for better Government of persons within the state. It includes offences against the law. Prohibition of certain act or omission is total. It is to be observed by all. Its contravention is punishable with fine, imprisonment or death. The purpose of criminal law is to safeguard the interests of the community and maintains a proper order and peace in the society. (Fig 2.1)

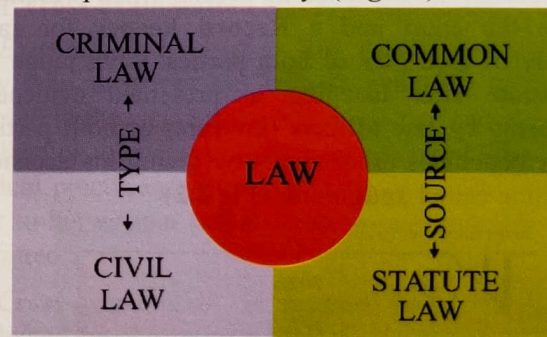


Fig 2.1: Sources and types of Law

Pakistan is an Islamic Republic and it has been strongly felt that criminal portion of inherited *English laws* pertaining to offences against the person, education and practice of economic policies are not in conformity with the Islamic principles. These laws need amendment, hence **Shariat Ordinance 1988**.

Shariat Ordinance 1988 basis is Islamic faith that sovereignty over entire universe belongs to Almighty Allah alone and exercise of authority by the people must be within the limits prescribed by Him. All Muslim residents in the country therefore, should adopt their lives in individual capacity and in collective spheres in accordance with the teachings of Islam as set out in *Holy Quran* and *Sunnah*. This principle is basis of creation of Pakistan and included in Objective Resolution 1940 and Constitution of Islamic Republic of Pakistan. Shariat has been declared by state as supreme source of law and grand norms of guidance for policy and law making.

Since enactment of Shariat Ordinance 1988, whenever a question should arise before a court of law that existing law is repugnant to Shariat, it shall refer the matter to Shariat Court for decision on the issue. Law further provides for appointments of qualified Aalim well versed with Islamic Shariat as judge, Mufties for guidance and interpretation of Islamic Jurisprudence in Supreme and High Courts and establishment of the following:

- Islamic Ideology Council
- Federal Judicial Academy
- Economic and Education Commissions

Court of law is a specifically established place where aggrieved people bring cases to seek remedies against a defaulter or an aggressor for decision. There are two types of courts of law namely *Civil* and *Criminal* presided over by a judge. When an individual is accused of breaking a contract or criminal law, the complaint is brought for trial before respective court. It is supported in work by a **Reader** who maintains dates of hearing of cases, a **Typist** who records the evidence in writing when presented before the court and a **Record keeper** for safe custody of case files of both parties. Civil judge or Magistrate after listening to presented evidence, arguments by law officers (lawyers) of both parties finally concludes proceedings by giving his decision in writing called **Judgment**. (Fig 2.2)

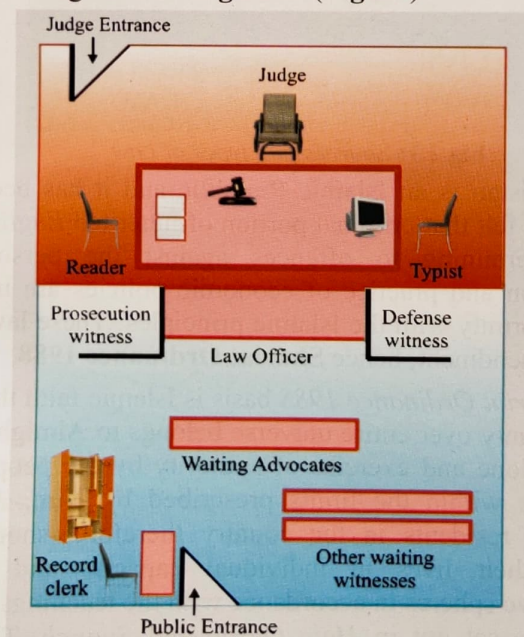


Fig 2.2: Layout of typical Courtroom

Civil and criminal courts have three levels; courts of first, second and third instance:

Courts of first instance have small jurisdiction consisting of an illaqa. There are many in a district, depending upon crime index and area population. They are presided over by either Civil Judges or Magistrates and hear cases of ordinary nature.

Courts of second instance are above those of first instance. They have larger jurisdiction spread over whole district, hear cases, which are more serious and presided over by District/Session Judges. Additionally they hear appeals against decisions of courts below them.^{1st}

Courts of third instance are High Courts, the highest in a Province. They are presided over by either a single Judge or a bench consisting of two or more Judges. They have both civil and criminal jurisdictions and hear mainly appeals against decisions of courts lower to it them. (Fig 2.3)

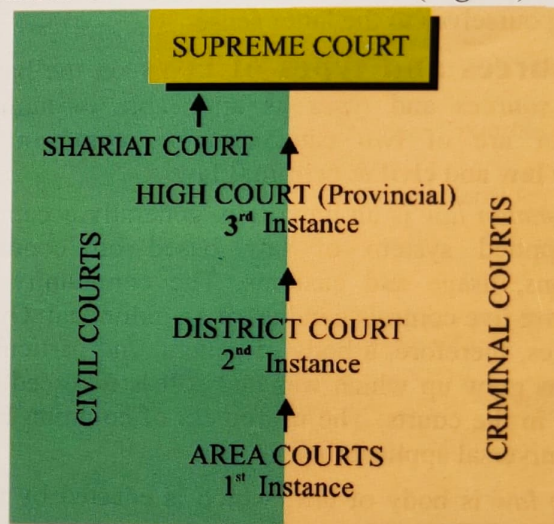


Fig 2.3: Organization of law Courts

Registered Medical Practitioner is mostly summoned by Courts of Magistrates and District/Session Judges and very rarely High Courts. He goes there to give evidence concerning medical examination conducted by him. It is an important duty in connection with furthering of justice. Before entering court room, he should appreciate the atmosphere of court, which is quite different from that of the hospital. It is tense and highly disciplined, but respectful. He should remember that he will be asked to come to witness box to present evidence. His evidence generally comprises of medical facts and opinion recorded by him in medical certificate issued to of victim of an assault having injuries or accused causing them. He is also required to answer question raised by prosecution, defense and court about his medical observations and opinion.

Careful appraisal of situation of court room atmosphere points to fact that task of court attendance is of immense importance, but different from one that is undertaken in hospital. Further, it is emphasized that the powers of the court to call a witness including Registered Medical Practitioner to attend the court of law for purposes of giving evidence are enormous. There are many ways and such call should never be refused. (Table 2.1)

Table 2.1:

Powers and ways to call witness

Summons	Must be obeyed and not refused. If ineffective
First call	
Warrants to arrest*	Witness arrested and produced
Second call	in the court
Written proclamation/	Aggressive way to compel court
Execution of bond**	attendance
Third call	

*, ** embarrassing for Registered Medical Practitioner, not adopted by court

Court evidence is fact/facts in an issue, which a witness knows through perceiving it by his own senses of vision, hearing, smell, taste and touch. It is presented after taking **oath, in person** and **orally** for acceptance of court of law. Besides, **written evidence** either hand written or mechanically printed is also admissible in the court of law for its inspection. Hospital notes including treatment chart and results of medical investigation can be received in court evidence. Medical publications can also be presented before the medical practitioner to authenticate medical opinion. Written notes may be **primary** or **secondary**:

Primary means and includes original and if it consists of several parts, each of its part.

Secondary means and includes certified copy made from original by any process that ensures accuracy.

Court evidence is of three types; **direct** or **circumstantial evidence** and **opinion of an expert**.

Direct evidence proves the existence or nonexistence of a fact in an issue that a witness knows. Car accident hitting a victim while crossing road, the evidence of eye witness where and how the victim was hit falls in this category.

Circumstantial evidence tends to prove a fact by process of inference i.e. fact inferred from another fact. A dead person is lying on a road, close by broken wind screen pieces and car tyre marks offer circumstantial evidence of a road accident.

Opinion of an expert is conclusion upon technical matter observed by trained and qualified person in

respect of his specialty. Opinion of medical examiner about weapon of offence when based upon characteristics of wound comes in this category.

Printed material in a technical book is also a form of opinion that may be produced to represent the opinion of the author. Its acceptance is subject to the conditions that author is either dead or incapable of giving evidence and expense of summoning is unreasonable in the eyes of court of law.

Purpose of court evidence is to lay before the court of law entire what a witness knows about the case. He should not omit anything for any reason. It is presented within hearing of accused and judge. Requirement under the law is to convey to the court of the law everything truthfully with an opportunity to accused for cross-examination. It should be factual and relevant.

Stages of court evidence including medical practitioner's evidence are three: **Examination-in-chief, cross-examination** and **re examination**.

Examination-in-chief is first and main part and party who produces the witness conducts it. Facts deposed in this stage must be within the memory and recollection of witness. Only scientific witness like medical practitioner or ballistic expert is allowed to refer to his written notes. Leading questions are not permitted.

Cross-examination is second part, which is conducted by the party who defends the case. It is required to test credibility of the witness, accuracy of evidence and willful omission if any. Leading questions are allowed.

Re-examination is third stage providing an opportunity to rectify discrepancies that may occur due to cross-examination. Court may ask questions during any stage of examination to clarify the facts.

Evidence Act guides witnesses in respect of presentation of court evidence. It is a complex law, which has codified rules of English law with such modifications as were considered necessary by peculiar circumstances of our country. Occasionally during court proceeding, difficulty does arise for which principles of common law are adhered to. It prevents laxity in the admissibility of court evidence and introduces a more uniform rule of practice. Main principle for acceptance of court evidence is that it is relevant, confined to matter in an issue and the best evidence.

While in the witness box, he should adhere strictly to Evidence Act, which provides guidance in the presentation of court evidence. (Table 2.2)

Table 2.2:**Guiding principles of presentation of medical evidence**

- Be familiar with case and take record to court
- Speak briefly, clearly and in non-technical language
- When questioned, listen carefully before giving its answer
- Address the court as Sir. Court is generally sympathetic to medical witness
- Do not evade a question, admit lack of knowledge and there is no disgrace admitting it
- If not agree with a suggestion, disagree firmly, but politely
- Never attempt to comment on subject, which is outside sphere of competence
- Be impartial
- Read carefully page of book presented for opinion, note name of the author, edition of the book and only then offer comment
- Get permission of the court before leaving and ask travel expenses

Medical Practitioner's Testimony

consists of two parts:

- First part comprises of observe d fact noted in the medical certificate during medical examination about condition of an injury, intoxication, disease or health of examinee. Example of fact about injury is its number, their sites, sizes, shapes, condition of their margins and extent of hemorrhage.
- Second part is framed opinion or inference drawn by medical practitioner from above stated fact and taking the same case of injury would include weapon of causation; *sharp* or *blunt*, gravity of injury; *simple*, *serious* or *dangerous* and age of injury; *fresh* or *old*.

After completion of formality of court evidence and its acceptance by court of law, it is called **deposition**, which is of two types; **deposition** and

dying deposition.

Deposition is statement of a witness given on oath in the court of law, taken down in writing in the presence and hearing of the accused and subsequently read over and signed by person making it and by the judge.

Dying Deposition is statement of a witness who is serious illness and is unable to come to the court of law to record his evidence. Court of law will go to him for this purpose. Conditions of deposition will be fulfilled at the place where the witness is lying, may it be his house or hospital.

Hearsay Evidence is an evidence of something, which the witness does not know for himself but has heard of it from somebody else. It is not admissible in the court of law except **dying declaration**.

Dying declaration is a statement of a dying victim of criminal assault, recorded by a credible person about "who assaulted the victim and other circumstances leading to his precarious condition that his death is imminent". Victim is the only eye witness and there is no time left to arrange a dying deposition.

Medical Practitioner in attendance and in-charge of such a patient would be the logical choice to record dying declaration. He should not shrink this legal duty. Being the best judge about physical health and mental condition of the victim ought to know what to do in such a situation.

Difference between dying declaration and dying deposition and condition of admissibility should not be forgotten. Victim being the only eye witness cannot be produced in the court of law after his death. Further, there is an assumption that impending death compels injured to speak the truth. (Table 2.3)

Table 2.3:**Difference between dying declaration and dying deposition**

Delay Declaration	Dying Deposition
1. Legal formality of oath is not necessary	1. Oath is an essential prerequisite
2. Recorded by any credible person including the attending medical practitioner	2. Only a justice of peace to record it
3. Presence of the accused is not necessary	3. Presence of accused is essential
4. A case of criminal homicide and circumstances of death subject of declaration	4. Recorded in any case when the witness is critically ill
5. Includes only the statement of the dying person	5. Includes the statement of the dying person and cross-examination by the accused
6. Read over to him and got signed if possible	6. Signature of the dying witness is necessary
7. After recording sent to illaqa magistrate sealed	7. Formality not necessary, being recorded by the justice of peace himself
8. Valid only after death of declarant	8. Remain valid even after the recovery of declarant

Legal procedure means legal proceedings conducted during a trial in the court of law, while the court is in session. Legal proceeding differs in civil and criminal courts. Civil court deals with breaking of contracts and there are always two parties for and against. Both parties bring witnesses to narrate and support allegations/assertions before the court of law. Duty to produce witness's rests on the party who makes the allegation, but onus of prove may shift from one party to the other during the course of proceedings. For example, in a case of divorce brought by wife for dissolution of marriage due to impotence of the husband has to prove non-consummation of marriage. If during trial her husband claims potency and makes an allegation that his wife suffers from veganism, the onus shall shift to him.

On the other hand, criminal court deals with accused guilty of a crime. State is prosecutor and its duty is to bring witnesses and also to prove commission of crime. It is done keeping in mind essential components affecting criminal responsibility, having two elements; **presumption and exception**:

Presumption is that everyone is responsible for his action, innocent until proved guilty and at the conclusion of criminal case, if court is in any reasonable doubt about allegation of commission of crime, the case shall be resolved in favor of the accused.

Exception negates criminal responsibility of the accused and is also three. They are immaturity, insanity or intoxication at the time of commission of crime. A child under the age of ten, an adult suffering from mental illness and an intoxicated individual are not considered competent to understand the nature and consequences of their action thus are not guilty. As regards intoxication, its intake must be without the knowledge or will of the accused. It means that the accused must not have acted voluntarily without external influence of force, drug or disease.

When the plea of insanity is raised by the defense during legal proceeding, the issue of criminal responsibility of the accused has to be resolved in accordance with **McNaughton's rule** originated in United Kingdom in 1843. (Table 2.4)

Both medical and legal authorities are in agreement that no test employed presently is perfect to resolve the issue of criminal responsibility. McNaughton's Rules has also been criticized as it

fails to exculpate those criminal acts, which are products of a truly disease of mind.

Table 2.4:

Stipulations of McNaughton's rules

Defendant has to prove that

- At the time of commission of crime, he was suffering from defect of reason
- Defect of reason was due to disease of mind
- Due to disease of mind;
 - i. He did not know nature and quality of his action
 - ii. If he did know nature and quality of his action, he did not know, was doing wrong

Americans have supplemented the McNaughton's Rules by '**Irresistible Impulse**' also known as '**Policeman at the shoulder**' meaning that the defendant, by reasons of disease of mind, would have acted as he did even had a policeman been standing at his side.

Durham Rule postulated in 1954 by the United States Court of Appeal has improved this situation and following it, an accused is not criminally responsible if his unlawful act is the product of mental disease. In contrast to the McNaughton's Rules, which takes into account the defendant's capacity to make moral judgment, the Durham Rule is based on purely medical concepts. In cases of defense plea of involuntary intoxication due to alcohol or other drug and mental immaturity of a child, medical evidence has only a probative value.

Plea of insanity, when raised in criminal cases as a defense during the course of proceedings may result in any of the three verdicts:

- *Unfit to plead*, applicable when the defendant was sane at the time of commission of crime but has subsequently become insane and thus not capable of defending himself. The court proceeding gets suspended till such time that defendant's sanity is restored.
- *Guilty but insane*, applicable when the defendant was insane at the time of commission of crime gets completely absolved of guilt and sent to mental hospital for his treatment.
- *Diminished responsibility* is applicable to defendant who is not absolved completely, but the severity of his sentence gets mitigated or reduced.

Criminal Justice revolves around two areas of interest to the medical practitioner; **substantive criminal law and legal definitions**:

Substantive criminal law deals with definition of a crime. Definition of crime always contains some mental element to manifest purpose or intent. Latin phrase ***mens-rea*** connotes evil or criminal intent, which is pre-requisite to guilt and thus a condition precedent to liability of the crime. Law does not punish evil thought and punishment is awarded for harmful result, which follows execution of the very criminal intention. In addition to *mens-rea*, there has

to be a following action that would indicate implementation of the criminal intention. Latin phrase ***actus-reus*** represents evil action. In the absence of either of the two, the crime cannot be considered as committed.

Legal definitions, which are applicable to all cases, are given in. (Table 2.5)

Table 2.5:

General legal definitions

Terms	Definition
Judge	A person who is officially designated or empowered by law to give, in any legal proceeding civil or criminal, a definitive judgment.
Court of Justice	A Judge or a body of judges who are empowered by law to act judicially alone or collectively.
Document	Any matter expressed or described upon any substance by means of letter, figures or marks, or by more than one of these means, which may be used, as evidence of that matter.
Offence	A thing made punishable by Pakistan Penal Code
Oath	A solemn affirmation specified by law, to be made before a public servant for the purpose of proof, whether in a court of justice or not.
Injury	Any harm whatever illegally caused to any person, in body, mind, reputation or property.
Assault	Whoever makes any gesture or any preparation intending or knowing it to be likely that such gesture or preparation will cause any person present to apprehend that he who makes that gesture or preparation is about to use criminal force to that person, is said to commit an assault. Mere words do not amount to an assault but the words which a person uses may give to his gesture or preparation such a meaning as may make those gestures or preparations mount to an assault.
Good faith	Anything done with due care and attention is said to be done in good faith.
Complaint	An oral or written allegation made to a magistrate to take action against a person who has committed an offence. This does not include a police
Inquiry	Any investigation other than a trial conducted by a magistrate or court.
Investigation	Proceedings undertaken for collection of evidence by police or anyone other than a magistrate, under the direction of the Code of Criminal Procedures
Judicial proceeding	Any proceeding in the course of which evidence is or may be legally taken on oath
Public prosecutor	Any person appointed under the law or his representative and any person conducting on behalf of the state in any High Court in exercise of its original criminal jurisdiction.
Summons	Written, signed and stamped directions of a court to a witness, accused or a juror to attend the court at the notified time, date and place.
Warrant of arrest	Written, signed and stamped authority to arrest a person, which shall remain in force till its execution or cancellation
Bail	A bond entered into, to ensure the appearance of an accused person at the time and place of trial
Deposition	A statement given on oath before a justice, taken down in writing, in the presence and hearing of the accused and subsequently read to and signed by the person making it and also the Justice.
Affidavit commissioner)	A written statement given on oath before any person authorized to administer an oath (oath

3. Legal Aspects of Medical Practice

Art of healing/Medical Practice

initially started a self-proclaimed profession with no concept of prior learning under supervision or control over it. There was also no sharing of one's skill or remedy with other healers. Everyone was free to join this business and adopt this art with two legal conditions of common law i.e. healer obtains consent of sick person before actual application of skill/remedy and is responsible for resultant damage (negligence).

Shaping of medical practice started around 13th century with introduction of certain period of training and its certification by an authority, but without supervisory control of defined professional body. Its earlier development revolved only around skills/remedies invented by natives of different countries like Ayurvedic medicine in India, Herbal and Acupuncture medicine in China and Unani Tib in Middle East and South Asia. With improved communication amongst nation for merchandize locally developed medicines/system traveled and got introduced other countries.

Allopathic system of medical practice, which is based upon proven scientific principles started sometimes later in Europe/United States. It is now the most modern system of medicine, which has replaced other systems of medicine and practiced all over the world. It has its own formally trained qualified and registered medical practitioners along with supportive nursing and paramedic services. Further medicine, isotope and implants used during its practice are vigorously tested both for effectiveness and safety before marketing and use. It has achieved unbelievable strides like increase in age span, extinction of infectious diseases, prevention and cure of many physical illnesses.

Introduction of sophisticated techniques like cloning and organ-transplantation have necessitated much stricter legal and ethical control. Laws have been streamlined to differentiate various type of medical practice, their qualification from each other and also laid regulations for protection of general public. As principally concerned with allopathic system of medicine, its related state laws should be discussed (**Table 3.1**)

Table 3.1:

Relevant state laws

- Allopathic system of medicine
- Medical treatment procedures
- Professional secrecy
- Medical documentation
- Medical ethics

Allopathic system of medicine statue law mainly is three and should be in the knowledge of registered medical practitioners of this system:

- **Pakistan Medical and Dental Council Ordinance 1962**
- **Allopathic medicine (Prevention of misuse) Act 1962**
- **Medical and Dental Degree Ordinance 1980**

Pakistan Medical and Dental Council Ordinance 1962 has two specific objectives; to establish a statutory body consisting of registered medical and dental practitioners (RMP/RDP) called Pakistan medical and Dental council (PMDC) and to perform allocated duties. Besides, medical and dental members, there is one legal member, ex-judge of High or Supreme Court and nominated by Chief Justice. Members, either elected or nominated should be Pakistani and residing in the country to participate in meetings of the council. Term is five years, elect a President, an Executive Committee and also constitute Sub-committees (2 or 3) depending upon need to perform allocated duties.

Allocated duties of the council are performed through its President, assisted by Executive Committee and Sub-Committees and mainly are:

- **Maintenance of register of RMPs/RDPs**
- **Monitoring of standards of medical and dental proficiency**
- **Professional conduct scrutiny**

Maintenance of register of RMPs/RDPs involves its preparation and updating. Register contains names of all RMPs/RDPs, entered in two parts i.e. A and B and each further having two sections, 1 and 2. Duty is performed by Registrar of the council under supervision of President. All medical and dental practitioners, irrespective of their status, have to register and inform any change of place of duty or practice. Registration grants privileges and imposes obligations. Register is a public document within the

meaning of Evidence Act 1872 and is open to inspection by public. (Table 3.2)

Monitoring of standards of medical and dental proficiency is achieved by a three pronged strategy:

- (i) Prescribing eligibility criteria for appointment (qualification and teaching experience) of medical and dental teachers
- (ii) Evaluating medical and dental courses of studies for quantum, standard and duration

- (iii) Inspecting medical and dental institution for teaching facilities and method of examinations

PMDC sends Inspection teams to medical and dental institutions periodically during years of studies and prepare recommendations for recognition of newly established institutions or withdrawal of recognition of already approved ones by Federal Government. (Fig 3.1)

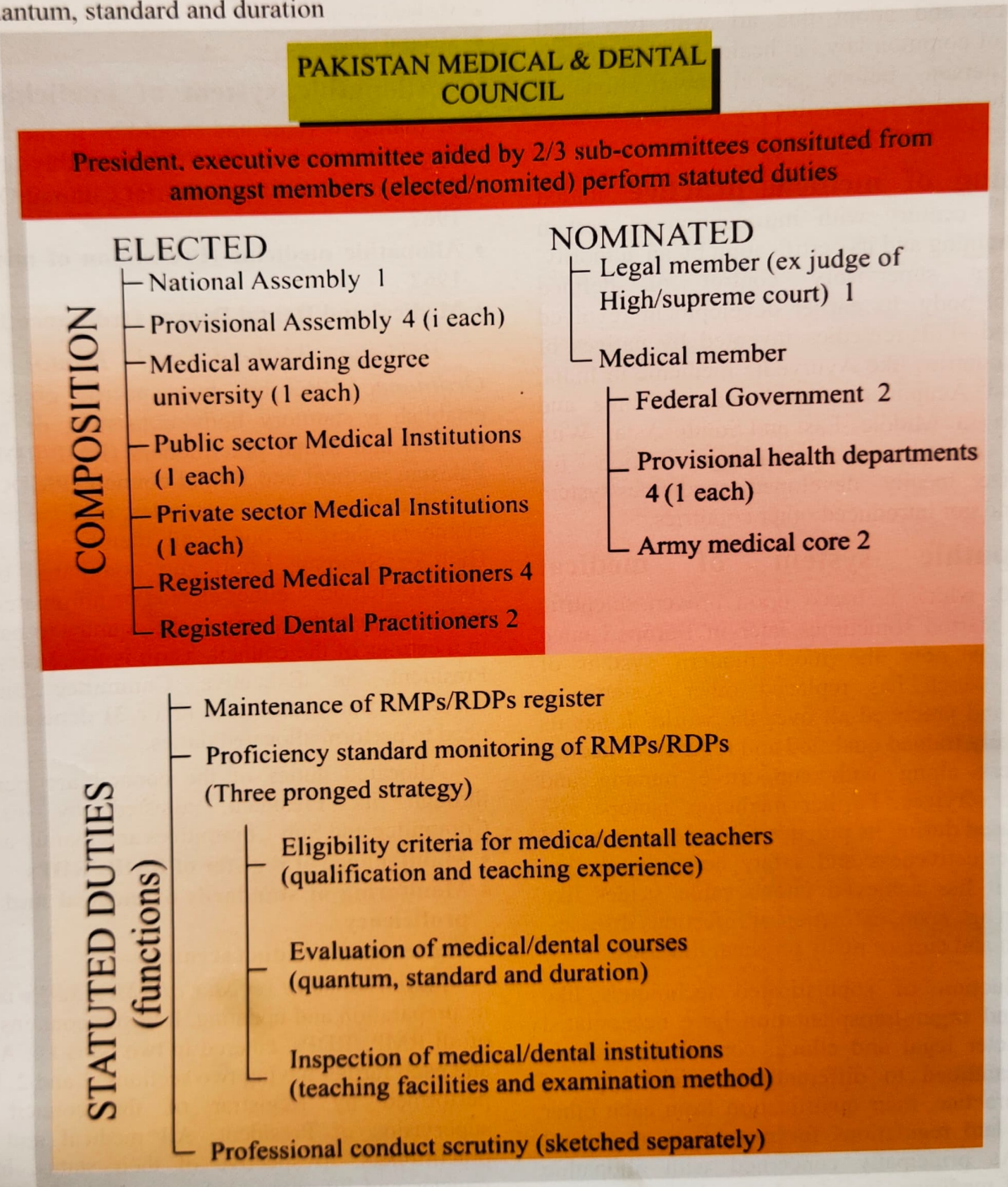


Fig 3.1: Constitution of Pakistan Medical and Dental Council

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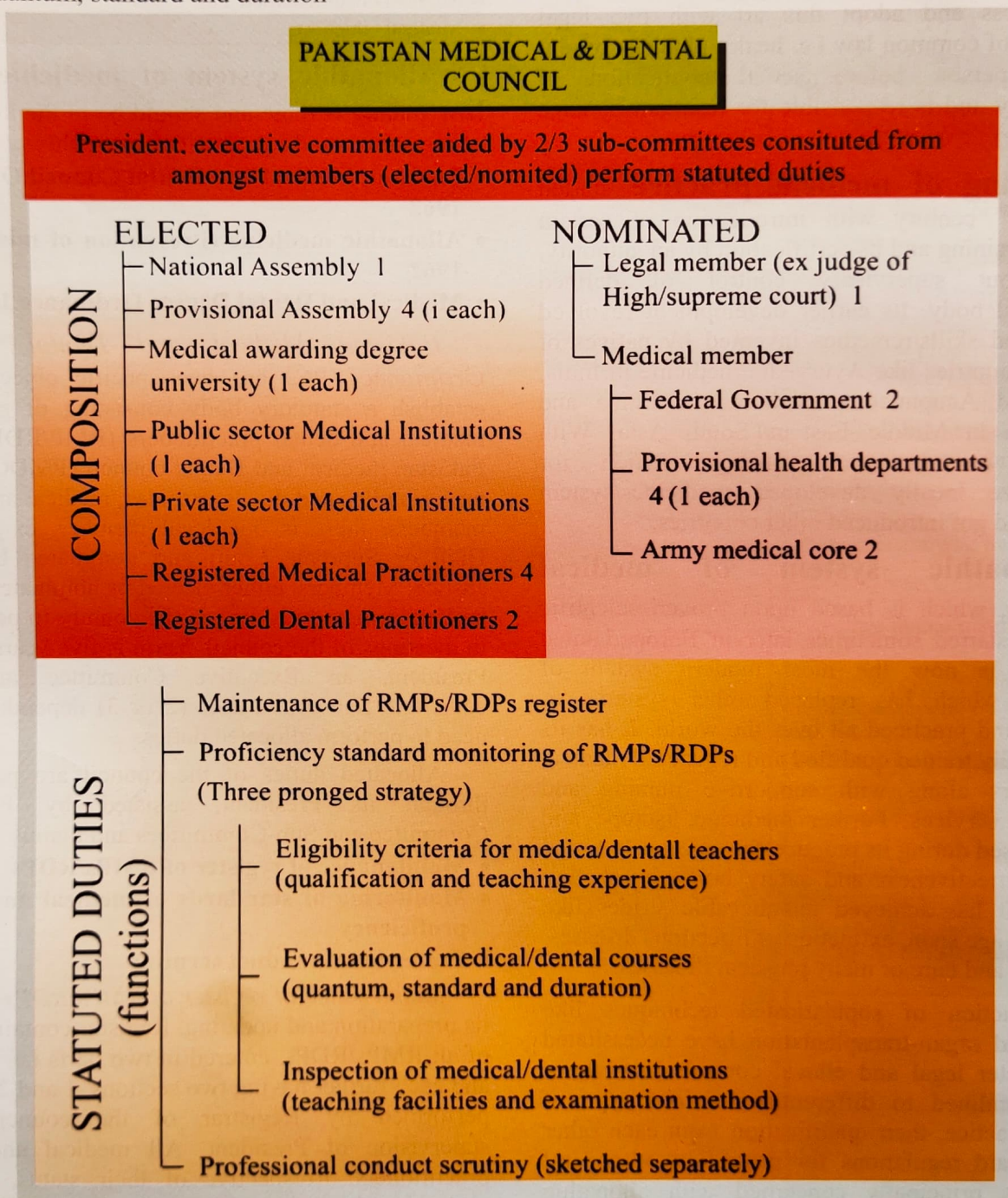


Fig 3.1: Constitution of Pakistan Medical and Dental Council

Professional conduct scrutiny of registered medical and dental practitioners is one of the responsibilities of the Council. **Disciplinary Committee** of the council exists to hold court of inquiry for this purpose. Proceedings start upon receipt of a complaint of **professional misconduct** during medical practice. A patient himself, Hospital Administrator and Court of Law after criminal conviction of medical practitioner approach Council for this purpose. Such references are addressed to the President of the Council, who asks explanation of concerned medical practitioner. If explanation is accepted, he declares the complaint as frivolous and

dismisses it. But if there is substance worth decision, complaint is forwarded by President to Disciplinary Committee for instituting a formal court of inquiry. At conclusion of court of inquiry RMP/RDP may receive either a warning with an advice to improve professional conduct, his name temporarily suspended for a period, if gravity of misconduct falls short of moral turpitude or removed permanently from the register, when charges against him are serious amounting to moral turpitude. His name is never removed arbitrarily. (Fig 3.2)

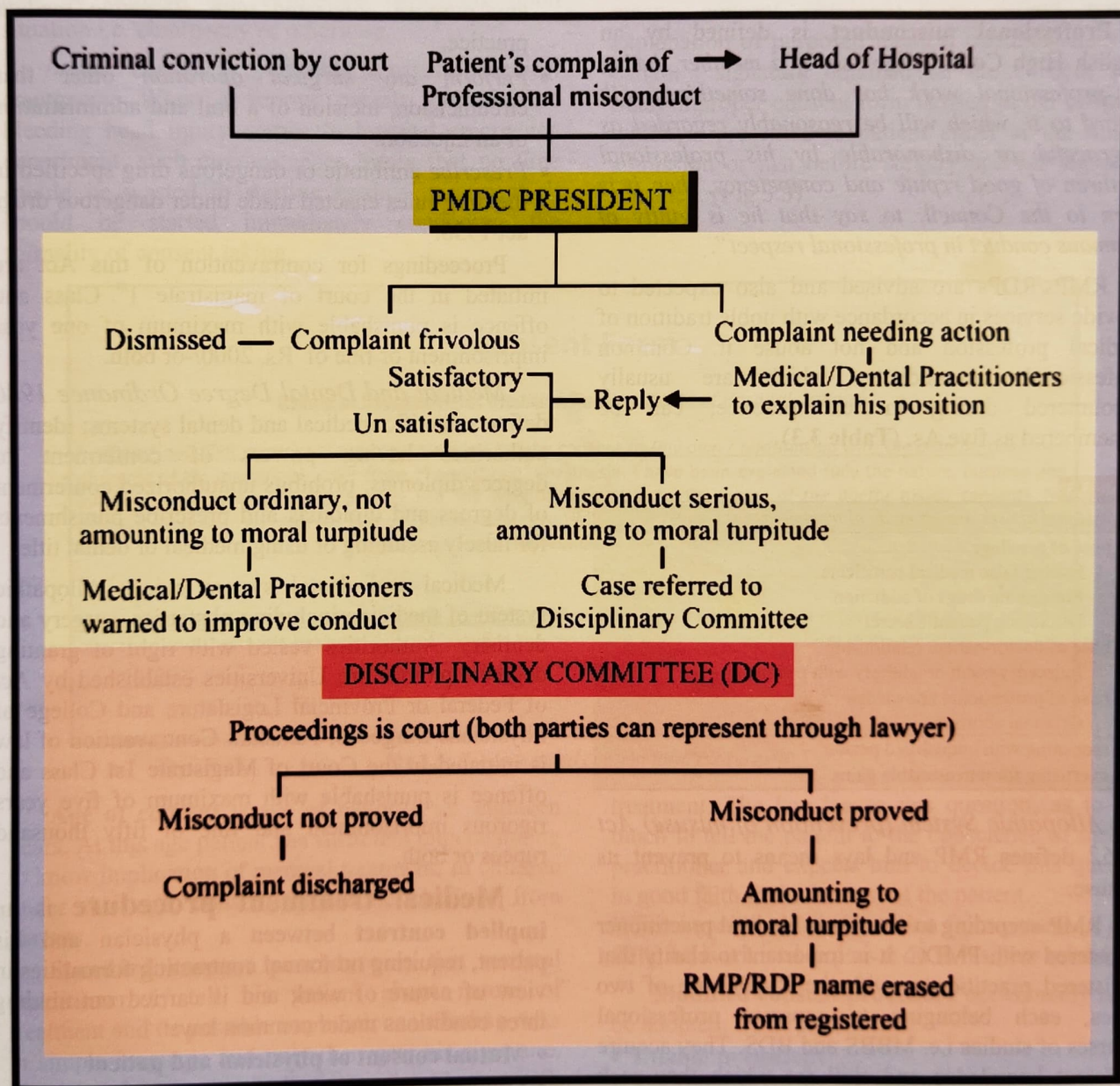


Fig 3.2: Flow chart of PMDC disciplinary proceeding

Table 3.2:

Privileges and obligations of RMPs and RDPs

Privileges

- Employment against job/establishment of an independent medical practice
- Issue medical certificate to patient for administrative and judicial purposes
- Charging of fee for rendered medical/dental services

Obligations

- Notification of change of address of practice or transfer within a period for 30 days of the change
- Not using any name, title, description or abbreviation indicating that he possesses additional qualification, which is not conferred on him.

Professional misconduct is defined by an English High Court Judge as, "If a member during his professional work has done something with regard to it, which will be reasonably regarded as disgraceful or dishonorable by his professional brethren of good repute and competency, then it is open to the Council, to say that he is guilty of infamous conduct in professional respect".

RMPs/RDPs are advised and also expected to provide services in accordance with noble tradition of medical profession and not abuse it. Common professional misconducts, which are usually encountered during medical practice, can be remembered as five As. (Table 3.3)

Table 3.3:

Professional abuses during medical treatment

- Abuse of privilege
 - Issuing false medical certificate
 - Prescribing drugs of addiction
 - Disclosing patient's secret
- Abuse of doctor-patient relationship
 - Indecent assault or adultery with patient
- Abuse of professional knowledge
 - Criminal abortion
- Associating with unqualified person
- Advertising for unreasonable gains

Allopathic System (prevention of misuse) Act 1962 defines RMP and lays means to prevent its misuse.

RMP according to act means medical practitioner registered with PMDC. It is important to clarify that registered practitioners with the PMDC are of two types, each belonging to separate professional courses of studies i.e. MBBS and BDS. They acquire different knowledge and skill for which they seek registration with PMDC to be eligible for respective professional practice. Law not appreciating the

difference has prescribed single phrase "registered medical practitioner". Actually it should have been "registered medical practitioner/registered dental practitioner" so that both practitioners stand covered by enacted clause.

Misuse of Allopathic System under the act is directed that *no one other than RMP* shall use:

- *Word doctor* or any of its grammatical variations, cognate expressions or abbreviations to give an impression that he/she is entitled to practice allopathic medicine.
- *Medical degree or diploma* to give an impression that he/she is a qualified medical practitioner or for any purpose connected with allopathic medical practice.
- *Perform any surgical operation* other than circumcision, incision of a boil and administration of an injection.
- *Prescribe* antibiotic or dangerous drug specified in the drug rules enacted made under dangerous drugs act 1930.

Proceedings for contravention of this Act are initiated in the court of magistrate 1st Class and offence is punishable with maximum of one year imprisonment or fine of Rs. 2000/-or both.

Medical and Dental Degree Ordinance 1980 define scientific medical and dental systems; identify authorities having powers of conferment of degrees/diplomas; prohibits unauthorized conferment of degrees and diplomas and prescribe punishments for falsely assuming or using medical or dental title.

Medical and dental system means Allopathic system of medicine including obstetrics, surgery and dentistry. Authorities vested with right of granting degree/diplomas are Universities established by Act of Federal or Provincial Legislature and College of Physicians Surgeons, Pakistan. Contravention of law is initiated in the Court of Magistrate 1st Class and offence is punishable with maximum of five years rigorous imprisonment and fine of fifty thousand rupees or both.

Medical treatment procedure is an **implied contract** between a physician and his patient, requiring no formal contracting formalities in view of nature of work and is carried out abiding three conditions under common law:

- **Mutual consent of physician and patient**
- **Obligations of parties (patient's & physician's)**
- **Compensation for physician's negligence**

Mutual consent of physician and patient means simultaneous consent of both, which is pre-requisite for start of medical treatment. A patient is not obliged to submit to medical treatment, except when the disease is contagious to other members of society. It is necessary for all kinds of medical procedures whether undertaken for diagnosis or physical treatment. Special procedures such as administration of anesthesia, fluid infusion including blood transfusion and surgical intervention require written consent. Patient's consent does not absolve medical practitioner from his duty of reasonable carefulness. Consent should be complete and freely expressed and may be **implied** and **expressed** depending upon situation i.e. emergency or otherwise.

Implied consent is applicable in cases of medical emergency. When a serious patient with profuse bleeding head injury comes to hospital emergency department, such circumstances imply that no time should be wasted in starting medical treatment. It should be started immediately condoning the formality of consent taking.

Expressed consent is taken from all other cases than medical emergency. Patient, being owner of his body, understands to what he is consenting. Consent should be *informed* and is generally given orally by the patient himself. Written consent is better for evidential purpose. Both forms are valid in the eyes of law. Protocol of written consent should have following spaces for:

- Name of consenting patient
- Type of medical treatment with its risks
- Name of physician/surgeon whom consent given
- Signatures of physician/surgeon and patient

Blanket consent is not valid in eyes of law. It means consent obtained from patient without explanation of purposed medical treatment/risks and patient's signature obtained on the consent form. Such improper consent form is used in our hospitals, which is presented to patient either at the time of admission or just before surgery and his signatures obtained. (Fig 3.3)

Consent Form

(Name of Department of Medicine/Surgery, Name of Hospital, Lahore)

I, (name and CNIC number of the consentee), do hereby consent to (my own / relationship with the patient) operation of (name of the operation) under (type of anesthesia) anesthesia. I have been explained fully the nature, purpose and inherent risks involved in this Surgery and the type of anesthesia by Dr. (name of the doctor taking consent). No assurance has been given to me that any particular Surgeon will be performing the operation.

Signature/thumb impression of the Consentee _____
Date _____

I, (name and CNIC number of doctor taking consent), confirm that all relevant details in respect of the above referred operation and anesthesia has been fully explained to the consentee who has signed this form in my presence.

Signature of the doctor taking consent _____
Date _____

Fig 3.3: Recommended consent form for surgery

Age of consent is age of majority i.e. eighteen years. At this age patient has sufficient understanding to know implication of medical treatment. In children under this age, consent should be obtained from parents.

Standard consent procedure is that medical practitioner to tell his patient about nature of treatment and its possible implications including risks in simple language and only then gets his signature. Physician has marginal discretion in what to tell, especially when he honestly believes that to tell the whole is liable to impede or interfere with medical

treatment. The law leaves this question, as to how much to tell the patient to the conscience of medical practitioner and expects him to decide this question in good faith in the interest of the patient. When he withholds information from patient in good faith, he is advised to pass it on to his near relative.

Modified consent procedure occasionally has to be adopted, when patient is:

- Unable to consent
- Treatments involving organs of generation
- Newer surgical procedure

Unable to consent condition applies to under age, unconscious and mentally sick patients. Unto early 19th century mentally sick patients were considered moon-struck and called **lunatics** and **dangerous to society**. There was no concept of medical treatment and they were restrained in **lunatic asylum** in accordance with **Lunatic Asylum Act 1858**. Understanding of mental illness first necessitated replacement of Lunatic Asylum Act 1858 with **Mental Health Act 1912** and subsequent amendments substituted it with the latest **Mental Health Act 1973**, which described for the first time **mentally sick's admission procedure and his authority to consent**.

Mentally sick's admission procedure and his authority to consent depend upon his mental state and his family circumstances. They are three types:

- **Voluntary admission**
- **Temporary reception**
- **Reception order**

Voluntary admission is granted to mentally ill himself, who has proper insight into his condition and submits a written application to the administrator of mental hospital.

Admission is subject to the condition that his arrival be notified to two **mental hospital visitors** (MHV)* within 24 hours of his arrival, one of whom is a Registered Medical Practitioner. Period of stay in mental hospital is open and if he desires to leave, is allowed subject to his satisfactory mental condition. Otherwise he will not be allowed to leave mental hospital for next 24 hours and during the period *temporary reception* be arranged.

*MHV is a person of integrity, entrusted with the duty of guarding health and other interests such as food, sanitation, loading of the mentally sick during his stay in the hospital

Provincial Health Department notifies their names and number of such visitors depends upon the strength of the patients in a mental hospital i.e. small institution has three, one of whom is RMP and big hospital has more such visitors

MHV makes monthly inspection of the institution and record his findings in the Remark Book in respect of care and treatment given to the mentally sick patients by the staff of the institution for the information of the government so that remedial measure could be taken.

When a mentally sick patient accused/convicted of a crime is transferred from prison to a mental hospital, Inspector General of Prisons or other such authority

entrusted with this duty acts as MHV. He visits once in every six months to submit a report about mental status of such patient to higher authority.

Temporary reception is granted upon submitting a formal application on the prescribed form by a near relative having blood or marriage relation with mentally sick to administrator of mental hospital. Application should mention about mental condition of the patient and circumstances of the family necessitating admission into the mental hospital. It should be supported with two medical certificates issued by Registered Medical Practitioners, one of whom should not be his usual medical attendant. Medical certificates should indicate date of medical examination and whether medical examination had been conducted separately or in conjunction with each other. When medical examinations have been done separately, maximum interval between medical examinations should not be more than five days and recommendation remain valid only upto 14 days from the date of issue.

After receipt of formal application, administrator of the mental hospital accepts mentally sick and his reception notified to two MHV before expiry of the second day. Period of stay is six months and if by the expiry of this period, the patient has not recovered, he continues to remain in the mental hospital for another twenty-eight days during which a reception order shall be arranged.

Reception order is issued by court of area magistrate after submitting a written petition by a near relative having blood or marriage relations. Petition should indicate besides family circumstances necessitating admission, whether any such petition was made previously and was successful or not. Petition should also be supported with two medical certificates from two Registered Medical Practitioners, one of whom should be a government medical officer. In case one of the medical practitioners is related to mentally sick patient, this fact should be indicated in the medical certificate. Both medical examinations should have been done independently and separately. Medical certificates should also include symptoms and signs of insanity observed by the medical practitioners and other information's pertaining to the patient conveyed to medical practitioners by his relatives.

Petition on submission may either succeed to obtain a reception order or dismissed. When dismissed, reasons of dismissal have to be recorded by magistrate in writing. Further, reception order is

generally subject to the condition that the relative is ready to pay the cost and maintenance of medical treatment in mental hospital and administrator is willing to receive him. Period of stay is generally not indicated in the order and patient cannot be discharged without the permission of the court.

Besides the above procedures of intake of mentally sick into mental hospital, a Station House Officer of a police station may arrest a wandering, dangerous or cruelly treated mentally sick, he should produce him before area magistrate, who orders his medical examination by authorized Government medical practitioner, who make other inquiries regarding whereabouts of his relatives and either hand over to his relatives who are ready to take care of him or in case of their non-availability authorizes his detention in mental hospital for a period of ten days. Maximum period of detention is thirty days with two more such detentions of ten days each to grant reasonable time to locate his relatives who can arrange proper admission procedure.

Discharge of mentally sick is permitted by mental hospital administrator/admitting judicial authority subject to the condition that he is fully recovered or his mental condition is such that he can be allowed to go out of the institution under the supervision and care of his family. Information of his discharge from the hospital is notified to MHV within 24 hours of his leaving of institution. He can also be sent home for smaller periods on an application of his relative to the administrator. Dangerous/unfit mentally sick cannot be discharged.

Care of mentally sick means physical care. It is under the supervision of MHV. *Maintenance of person and estate* of mentally sick is under the control of area **District Judge** vested with the power to institute an inquisition into the mental status of an individual alleged as mentally sick. If a petition succeeds, it results in the appointment of guardian for maintenance of his person and manager for the management of his estate. Appointees perform duties under overall control of **Collector, Provincial Government**. Relatives qualify for appointment as manager of the estate, but there is a restriction to appointment of legal heir as guardian.

Treatments involving organs of generation like contraception and artificial insemination additionally require consent of spouse. There are generally three situations:

- a) Prescribing of contraceptive pill to treat menstrual irregularities is permitted without permission of the husband.
- b) Insertion of intrauterine device should not be affected without husband's consent, but insertion in order to save a woman from pregnancy, in view of her weak health is considered justified. Insertion after age of majority in order to avoid pregnancy even with the consent of both husband and wife though legal yet would be unethical.
- c) Tube ligation surgery, when performed in good faith, to prevent transmission of hereditary diseases or to save life of the mother in view of disease in which pregnancy might endanger her life, is permitted.
- d) Artificial insemination is deposit of semen in vagina, cervical canal or uterus by instruments to bring about pregnancy unattained by sexual intercourse. Seminal fluid used for this purpose either may be obtained from husband (A.I.H.) or from a donor (A.I.D.). There is no legal or ethical complication whatsoever with A.I.H. Religious objection however exists with A.I.D., besides insoluble legal problem regarding legitimacy of the resulting child. While registering such a birth, it is usual to give the details of the father to avoid a charge of adultery subsequently against the women being pregnant by another man. Medical profession regards the practice of A.I.D. unethical and it should be strongly discouraged.

Newer surgical procedure like organ transplantation, everyone is entitled to consent for removal of organ regarding his own body before his death. Such authority, if given, should be passed on to Head of Hospital for safe custody where arrangements for organ transplantation exist. When an individual is dead and consent of the deceased is not available, consent of next of kin should be obtained. In no case should an organ be removed in an unaccompanied case.

Besides, there are situations in which medical treatment though essential, urgent and life saving, yet patient and his guardian are reluctant or unable to consent:

- Narcotic use prohibited by religious faith
- Blood transfusion objected by Jehovah's witness
- Limb amputation delayed or refused by patient's indecision or non-availability of guardian

In such situation medical practitioner should obtain advice of a senior colleague and enter in case notes and then proceed with medical treatment.

Documentation of consent is an essential duty of medical practitioner. He should follow professional dictates in this respect while entering it in case files. He is advised to fully document adopted procedure and case circumstances and also obtained an endorsement of proposed treatment from a senior colleague before proceeding with the treatment. It secures his position against any subsequent complaint or a civil suit. (Fig 3.4)

CONSENT FOR MEDICAL TREATMENT					
From & by home		Which type	When taken	How taken	What documentation
(i) Patient	(i) Treating Practitioner	(i) Oral / written	Before	(i) Standard Procedure	(i) Consent form
(ii) Relative (by Blood/marriage)	(ii) Investigating Practitioner	(ii) Implied / Expressed	(I) Medical Examination, (ii) Investigation (iii) Skill Application	(ii) Modified Procedure	(ii) Endorsement from senior
(iii) Authority control patient	(iii) Operating Specialist	(iii) Blanket (Not recommended)			(iii) Placement of Papers in case file

Fig 3.4: Type, sequence and medical practitioner's role in consent taking

The situation is very critical. Patient's history of illness contains secrets even the most guarded ones, physical examination grants physical excess to his body along with all sorts of manipulation even private parts and provision of medical treatment includes administration of poisonous/drug of addiction and surgical cutting.

Physician's obligations are also two, firstly to apply skill with the competence of his own claim i.e. ordinary or expert and secondly to exercise carefulness in work towards his patient. Medical treatment once started should continue and proceed uninterruptedly till either full recovery, mutual termination, when medical practitioner refers the patient to another doctor and patient accepts it or death of the either party. Patient, however, can unilaterally discharge his physician when he is not satisfied with the medical treatment offered. (Fig. 3.5)

Compensation for physician's negligence is not condonable and no different from negligence of other artisans in the eyes of law. It is careless performance of professional work. Medical practitioner has a duty to conform to reasonable standard of carefulness, which should be exercised to avoid any fault leading to damage to patient's body. He is answerable and has to compensate his patient in terms of money. A personal belief that a particular treatment or technique is best is no defense, unless the belief is

Obligations of parties (Patient & Physician):

Patient's obligations are two, firstly to pay mutually agreed fee to physician. Medical practitioners in employment of an organization, Local Authority or Government are duty bound to provide medical treatment without charging of fee to its members. Secondly, to submit to legitimate command of physician as much as is professionally necessary.

based on reasonable ground. Further belief that a senior medical practitioner cannot be careless because he has many year of experience is not valid.

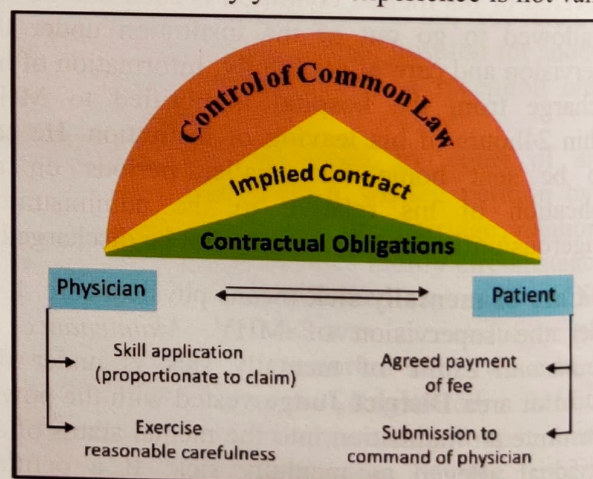


Fig 3.5: Contractual obligations of physician and patient and control of common law

It is necessary to point out that most of medical treatments are attended with risks and medical practitioners have to provide them in good faith in the interest of his patient. A reference to **iatrogenic disease**, the cause of which is supposedly physician is made here, as it pertains to practice of medicine. Side effects of medicines, complications during medical investigation and surgery are associated with medical treatment. They occur in spite of best efforts of the medical practitioner. Such situation should not

be included in the list of professional negligence. On many occasions, a complication or even death of the patient follows in spite of best efforts of the medical practitioner who is properly qualified, skilful and experienced. Can such unsuccessful attempts or misadventure be called professional negligence? The answer in such cases definitely should be in the negative.

Medical science has conferred great benefits on mankind by taking risks. We can't take benefits without taking risks. Doctors, like most of other professionals, have to learn by experience and learning by experience is attended with risk. It means that there is no negligence during misadventure but not to take precautions subsequently, clearly would be negligence. A clear distinction between the negligence and misadventure must be made.

Scope of medical negligence is unending because of rapid inventions in medical science and also not limited to the conduct of the medical practitioner alone. It extends to other staff members who are working under his supervision, especially in a hospital setting where responsibilities are shared by the whole team. There are generally three situations of provision of medical treatment; by general duty medical practitioner holding basic medical qualification, specialist holding additional medical qualification over and above basic medical qualification and general duty medical practitioner when an expert is needed who is not available and patient has consented. Level of skill and competency expected in first case is that of an ordinary physician; in the second is of an expert having additional duty of remaining abreast with the latest advances peculiar to his field and in the third, if medical treatment ends in misadventure, it would not be considered doing of the medical practitioner. In other words, medical practitioner working in adverse circumstances should not be judged and labeled as negligent.

Burden of proof of medical negligence nearly always rests on the patient, except a specific situation covered by common law doctrine "*Res Ipsa Loquitur*" meaning thing speaks for it. This doctrine creates an inference that negligence has occurred and places responsibility on the medical practitioner to offset the inference, if he can. The burden of proof in such a case shifts from the patient to the medical practitioner to prove that he is not negligent. It is applicable, when a medical instrument, which does not ordinarily cause injury unless the controlling

medical practitioner is negligent and injures the patient. Examples encountered are:

- Live electric cattery left unattended, burns patient's skin.
- "On-position" anesthesia machine with gas plug connected with the patient, when left unattended over anaesthetizes the patient.
- Surgical instrument left in the abdomen of the patient during surgery to initiate foreign body reaction.

Extend of damage and intern punishment in law to medical practitioner in claims of medical negligence will legally depend upon, whether medical negligence is categorized as **civil** or **criminal negligence**:

Civil negligence results from lack of carefulness during medical treatment and common examples are extraction of a healthy tooth instead of diseased one; failure to X-ray a fractured bone and not to give anti-tetanus vaccine following an injury. Such cases are brought before a *civil court* for decision of award of compensation in terms of money. Damages are not limited to the physical injury alone. The patient is entitled to recover damages for physical injury, pain and mental suffering along with any loss of earning capacity associated with the injury. This is why the claims awarded by civil courts are generally very extensive. Besides, there are two other situations; **contributory negligence** and **negligence of the third party**.

Contributory negligence as the name indicates is that someone else has contributed in resultant negligence. It results when patient becomes negligent and does not carry out medical instructions properly. Good result of medical treatment depends upon the exercise of carefulness by both the medical doctor and his patient. Law is very particular about the situation and does not ignore the negligence of the patient in this respect.

Negligence of third party results by carelessness of supportive paramedical staff in a hospital situation, where responsibilities of medical treatment are shared between medical practitioner and such staff. It proportionally reduces the liability of compensation from medical practitioner and shifts to paramedical staff.

Criminal negligence, on the other hand, results from gross and wicked recklessness on the part of medical practitioner, who shows no regard for the

safety of patient's life and causes patient's death. Examples are:

- (i) Over-anaesthetizing patient by an anesthesia addicted anesthetist solely to satisfy himself
- (ii) Leaving patient unattended by surgeon after opening his abdomen to negotiate fee with his relatives.

Such an attitude on the part of medical practitioner would surely result in death of the patient and in not condonable. The law/state punishes the wrongdoer, who is charged with manslaughter under criminal law in criminal court for punishment. (Fig 3.6)

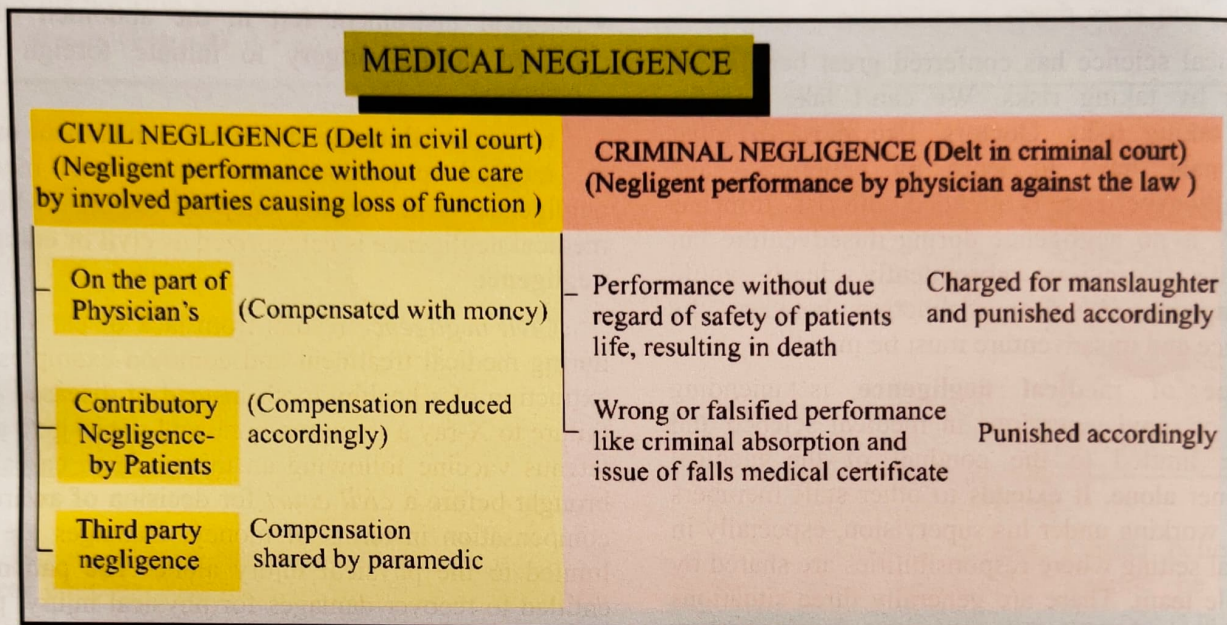


Fig 3.6: Types and consequences of medical negligence

Besides imposition of common law, provision of medical treatment is under-taken in accordance with noble traditions, accepted voluntarily by the medical profession and fall within the sphere of medical ethics.

Professional secrecy and its maintenance is an important ethical duty and also equally so in law. Patient's information about his disease received during medical practice due to doctor-patient relationship is a confidential communication between medical practitioner and his patient. It is a sacred trust and Hippocratic Oath affirms that medical practitioner will not divulge patient's secrets. It should be kept in secure place of the hospital away from public under direct control and supervision of medical practitioner.

Introduction and excessive use of computer and storage of patient's information in data bank for medical research has complicated medical practitioner's duty of preservation of patient's confidentiality. Courts so far have not commented upon its legal status. Professional bodies considered it justified.

Disclosure of patient's secrets by medical practitioner is a serious lapse and can lead to legal action against him in civil court as well as ethical action by disciplinary committee of PMDC. Courts have ruled that a medical practitioner has a common law duty of protecting confidentiality of patient's secrets in the context of doctor-patient relationship. But this is not absolute as the law also recognizes the propriety of careful disclosures to agencies, which qualifies to receive it for protection of the society.

Privileged communication is disclosure of patient's information to others having interest in it. In this context, doctor has a duty to disclose and it is considered justified in the eyes of law provided it is made in good faith in the course of legal duty with the precaution that the statement of disclosure is not malicious and the party receiving it has a duty to receive it. There are two type's disclosures under privilege communication; **qualified privilege** and **absolute privilege**. All notifications of birth, deaths and industrial, infectious or contagious diseases are examples of **qualified privilege**. Rationale of this disclosure is that the interest of the community is superior to that of an individual.

Another situation with which a medical practitioner may be confronted is during court attendance where disclosure of patient's information is compelled. Refusal may amount to contempt of court. Courts of law and parliament of the country has absolute authority to receive patient's information falling in the category of **absolute privilege**. (Fig 3.7)

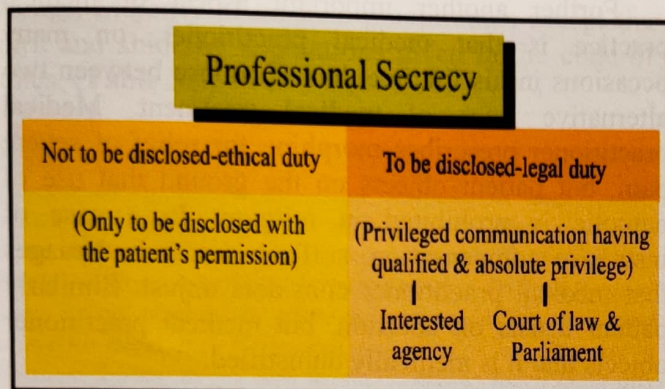


Fig 3.7: Principles governing professional secrecy

While appearing in the court of law to convey patient's information (condition) in cases of physical and sexual assaults or intoxication, medical practitioner should inform Justice of peace that he has a duty of professional secrecy towards patient's information and disclosure made.

Medical documentation is another highly important duty of medical practitioner during medical practice. Every country has some kind of system of preparation and proper documentation of medical record of patients for subsequent use. Important medical record to mention a few includes patients out/in-patient data registers, bed head folder of admitted patients, operation log register and patient's diseases abstract register. Each ought to have specific structure to fulfill the objective of its creation. All hospitals in a country should adopt them, so that state of health of population can finally be prepared for future planning. Situation in Pakistan is otherwise. Every hospital designs its own medical record documentation format. There is no standard protocol/design for guidance of medical students, fresh medical practitioners and statisticians. Further presence state of affairs is hurdle in linking countries data internationally.

Besides, the most common medical document in use during medical practice is **medical prescription**, **medical report**, **medical certificate** and **medical notification**. Each structurally consists of three portions. First and last portion is to fill-in personal

identity of patient and medical practitioner respectively. Central portion is meant for information/findings relevant to type of medical document in respect of patient.

Medical prescription is direction of medical practitioner, which is handed over to patient to send to pharmacist for dispensing medicine for use in the way indicated in it. It starts with letter "Rx.", which stands for the word **recipe**. It is followed serially as 1, 2 and 3 mentioning names of the medicines with their concentration and direction for use. At the end, medical practitioner signs and stamps the prescription bearing his name in capital letters, registration number and address.

It is necessary to point out that prescribing antibiotics and dangerous drugs is privilege only of registered medical practitioner by virtue of Allopathic system (prevention of Misuse) Act, 1962. Further, dangerous drug rules lay an additional duty of writing of **superscription**, stating repeat instruction of prescription for how many times. It should be written carefully and correctly, otherwise pharmacist may refuse to dispense the dangerous drug to the patient and he would be justified in doing so.

Medical report is prerogative of investigating medical practitioner like radiologist or pathologist. It starts with the phrase "*This is to report...*" and contains partial information limited to the purposed investigation like X-ray of patient's body part, a test of a material like bile, blood, urine or a biopsy from the patient's body. It is a small portion of patient's total condition only to gauge the level of his health or clinch diagnosis of the malady from which the patient is suspected of suffering. Medical report, being patient's confidential information, should be sent back to referring Medical Practitioner after enclosing it in an envelope.

Medical certificate preparation is the domain of formally notified medical examiner. It starts with the phrase "*This is to certify...*" It is complete and the most comprehensive information about state of physical health of an individual whether healthy or diseased. It is compiled after full physical examination of the body of the examinee and required investigations with their results to conclude finally with medical examiner's opinion regarding state of health or disease of the examinee at the time of examination.

The Most common examples of medical certificate are certificate for determination of age for

schooling, employment, marriage etc, sickness, temporary/permanent incapacitation after an injury.

Medical notification preparation is the responsibility of registered medical practitioners. It starts with the phrase "*This is to notify...*" It includes information about suspected diagnosis of infectious/contagious disease like cholera and leprosy and acute poisoning along with already administered medical treatment. Such cases require urgent hospitalization; it matters little whether diagnosis mentioned in the notification is correct or not.

Registered Medical Practitioner has a legal duty to notify infectious/contagious patients coming to their notice to authorities appointed by Municipal Medical Officer of Health.

Medical ethics is a subject of immense importance and its proper grasp requires understanding of word **ethics**.

Ethics is science or philosophy of morals dealing with general nature of morals and of specific moral choices to be made by an individual in his relationship with others. In another sense, ethics implies principles or standards governing the conduct of the member of a society. *Frankena* describes ethics as a part of field of philosophy and according to him; it is the study of morality, moral problem and moral judgment. It entails essentially an examination of *what is right* and *what is wrong*; *what is virtuous* and *what is evil* in the conduct of individuals and groups of individuals, emphasis being on what ought to be.

No man is an island unto himself. He is dependent on others and owes his existence to his relationship with others. He has to conduct himself in such a way, as he would like other to reciprocate. This is the essence of ethics. He will, throughout his life, come across situations when he will have to face ethical issues. These issues become more important in medical practice, because of special doctor-patient relationship, which exists between them. Situation is unique, but delicate and precarious. Physician has a privileged position having both skill and authority. Patient is at his mercy, helpless, dependent and vulnerable and in a state of complete surrender.

Physician behavior mostly consists of good manner and civilized behavior in the general sense. Besides, it includes peculiar issues of medical practice. (Table 3.4)

Table 3.4:

Issues peculiar to medical treatment

- Patient's history of illness means knowing his secrets even most guarded ones.
- Medical examination means physical excess to patient's body even private parts with all sorts of manipulations
- Medical treatment means administration of poison/ drug of addiction and surgical cutting of patient's body.

Further another important aspect of medical practice is that medical practitioner, on many occasions in his lifetime, has to choose between two alternative lines of medical treatment. Medical practitioner prescribes morphine for relief of severe pain, but patient objects on the ground that use of narcotic is prohibited in religion. In a case of insurance compensation, sufferer demands damages that medical practitioner considers unjust. Similarly patient insists on abortion, but medical practitioner objects that it is medically unjustified.

These are only few examples of numerous situations, in which the interest of one party comes into conflict with the scruples of the other. Resolving such dilemma involves ethical consideration. Proper understanding of the principles of ethical conduct in medical practice is necessary for their application to a particular situation. At each step during these procedures, he may succumb to human temptations and failings ranging from blackmail, extortion of money to sexual exploitation.

Formidable is his unending authority are chances for him to out-step his moral obligation and invade the rights of his patients. No law can check his action, numerous of which fall outside official legislation. **Only fear of God and scruples of his science can set the limitation.**

Scope of medical ethics is not fixed into rigid boundaries and continues to widen with new inventions and developments. The most recent examples of advancement are introduction of practice of organ transplantation, artificial insemination and cloning. Each new invention creates new problems requiring laying of fresh ethical principles suited to new situation. Guidelines in this respect to codify and publicize information regarding ethical consideration emerging from newer problems, would be useful to keep in mind the following golden troika; adherence to scientific basis, impartial presentation of scientific findings and dedication to serving justice.

Hippocratic Oath sworn by Greek physicians is the oldest and well known code of

ethics to medical persons. It contains promises of “**I will** and **I will not**” which are essential to the protection of the character of professional person. They make it clear that medical practitioner is neither an unthinking instrument of the client or employer, available to do things that they want nor willing to make knowledge and skill of the professional calling work for their interest irrespective of inherent wrongs. Majority of medical practitioners accept the spirit and abide by stipulations given in the code of ethics. (Table 3.5)

Table 3.5:**Translation of Hippocratic Oath**

“I swear by Apollo the physician, Aesculapius and Health, and all heal, and all the gods and goddesses, that according to my ability and judgment I will keep this Oath and this stipulation to reckon him who taught me this Art equally dear to me as my parents, to share my substance with him, and relieve his necessities if required, to look upon his offspring in the same footing as my own brothers, and to teach them this art, if they shall wish to learn it, without fee or stipulation, and that by precept, lecture and every other mode of instruction. I will impart knowledge of the art to my own son, and those of my teachers and to disciples bound by a stipulation and oath according to the law of medicine, but to none other. I will follow the system of regimen which, according to my ability and judgment, I consider for the benefit of my patients, and abstain from whatever is deleterious and mischievous, I will give no deadly medicine to anyone if asked, nor suggest any such counsel, and in like manner I will not give to a woman a peccary to produce abortion. With purity and holiness I will pass my life and practice my Art. I will not cut persons laboring under the stone, but will leave this to be done by men who are practitioners of this work. Into whatever houses I enter, I will go into them for the benefit of the sick, and will abstain from every voluntary act of mischief and corruption, and, further, from the seduction of females or males, of freemen or slaves, whatever, in connection with my professional practice, or not in connection with it, I see or hear, in the life of men, which ought to be spoken of abroad, I will not divulge, as reckoning that all such should be kept secret. While I continue to keep this Oath un-violated, may it be granted to me to enjoy life and the practice of the Art, respected by all men, in all times. But should I trespass and violate this Oath, may the reverse be my lot.”

Ethical Oath used to be pledged by all fresh entrants to the medical profession at their graduation ceremonies. Discontinuation of this practice resulted in gross transgression of medical ethics and intern disrepute to the medical profession. World Medical Association (WMA) in a conference in Geneva took cognizance of falling and deteriorating ethical standard; restated ethical oath in simple language and modern style known as **Declaration of Geneva** and recommended its adaptation at graduation ceremonies. With very slight modification Pakistan Medical and Dental Council Code of Medical Ethics is now based. (Table 3.6)

Table 3.6:**Code of ethics of PMDC**

“In the name of Allah, Most Gracious and Merciful I solemnly pledge that I shall abide by the principles laid down in the Code of Medical Ethics of the Pakistan and Dental Council. I further make solemn declaration that:
 I consecrate my life to the service of humanity.
 I will give to my teacher the respect and gratitude which is their due.
 I will practice my profession with conscience, dignity and fear God.
 Health of any patient will be my first consideration.
 I will respect the secrets, which are confined in me.
 I will maintain by all the means in my power, the honor and the noble traditions of the medical profession.
 My colleagues will be my brothers and sisters.
 I will not permit consideration of religion, nationality, race, party politics, social standings to intervene between my duty and my patient.
 I will maintain the utmost respect, for human life, from the time of conception: even under threat, and will not use my medical knowledge contrary to the laws of humanity.
 I make these promises solemnly, free and upon my honor.”

CHAPTER 4

4. Medical aspects of Law

Relationship between man and crime is as old as him. Starting from initial stage of primitive man to final stage of civilized man, change occurred in three chronological stages:

- During *earliest first stage of primitive-man*, who was mightiest, followed own dictum, "*might is right*". When assaulted, exercised vengeance upon aggressor having no relation to harm suffered by him
- During *second stage of intermediary-man*, he shared power with next mightier and shifting retaliation having single scale of penalty i.e. life for life and an eye for eye
- During *last final stage of civilized-man*, who accepted proportionate role of responsibility of crime and penalty scale reduced accordingly

Human-being is believed as creation of All Mighty Allah, blessed with only one life spread from cradle to grave, having purpose/function to perform.

Life begins with conception within the womb of mother, proceeds uninterruptedly passing through two defined periods; first pre-natal totally dependent upon mother and second post-natal totally independent of mother.

During life, an individual also passes through three biological phases of defined ages, which are important for purpose/function of life:

- **Proliferative phase**
- **Static phase**
- **Retrogressive phase**

Proliferative phase is continuation of pre-natal period into post-natal period to the age of puberty at 13/15. This phase is period of growth and his body (parts and organs) conforms into normal shape and continuously increasing in size including height and also acquire three functional abilities i.e. physical, sexual and intellectual, which are interdependent on each other. After this age, an individual is considered as fully developed for purpose/function of life.

Static phase is from age of puberty to age of onset of regression at 45/50. During this phase, there occurs no biological change affecting shape, size (height) and functional abilities of human body and remains fit for purpose of life.

Retrogressive phase is last age of onset of degeneration to that of senility. During this period, there occur decline in human body shape, size and

functional abilities, which continue till inevitable end point i.e. death.

First and third phases are comparatively less competent from second as regards purpose/function of life, thus have mitigation towards quality of actions and individual responsibility. (Fig.4.1)

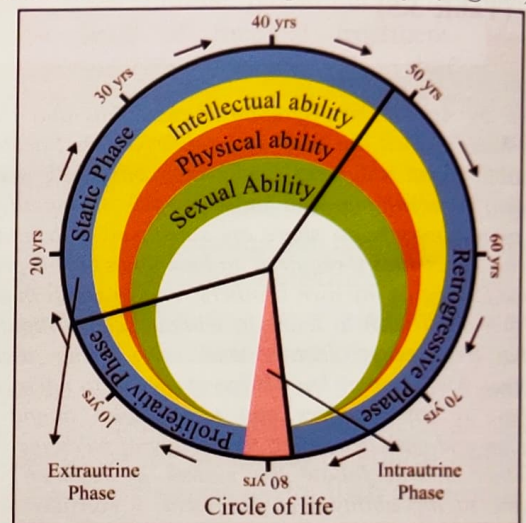


Fig 4.1: Phases of human body and their relationship to functional abilities

Jews, Christians and Muslims are unanimous that no one has any right to interfere into the purpose/function of life of other. This principle has been accepted and incorporated in criminal law codes. Criminal law while defining crime takes into consideration individual's age, gender, quality of his action and its consequences upon other. Such issues containing medical aspect of law are part of definition of crimes. Total list is extensive and going through them all is beyond the scope of this chapter. Some of them as examples are taken from criminal laws contained in Pakistan Penal code of offences against the person and are mentioned:

- Role of age, gender and potency/impotency especially in sexual offences
- Role of **mens-rea**, mental faculty manifesting purpose or intent of crime, also dependent upon being major/minor, intoxicated or suffering from mental illness
- Role of intoxicating (self/others) in Hadood ordinance,
- Role of wounding (self/others) and killing of fetus, self and others in Qisas & Diyat Ordinance

Qisas & Diyat Ordinance 1991 and **Hadood Ordinance 1976** has since been amended to bring them in conformity with the injunctions of Islam, thus reproduced.

Qisas & Diyat Ordinance 1991 has replaced terms of murder with **qatl** and **injury** with **hurt** and also gave new classifications denoting specific meanings. Proper understanding of changes of injury/wound requires knowing the following:

- From medical point of view, any break in the body tissue, externally or internally is termed as wound or injury. Both words are synonymous in meaning and are a single pathological entity.
- Law also defines injury as any harm caused illegally to any person in body, mind, reputation or property.
- Law has not defined word *wound* so far and prefers to use the term *hurt* for it instead.

Besides, amended law provides compensation for criminal hurt for the first time in the country introducing new legal terms of **Arsh**, **Daman** and **Diyat**, in addition to **Qisas**. (Table 4.1)

Table 4.1:

Names of terms and their descriptions	
Names of terms	Description
Arsh	Compensation not is specified in law for causing hurt and payable by the offender to the victim or his heirs.
Diyat	Compensation specified in law for causing hurt payable to the heirs of the victim, by the offender.
Daman	Compensation not liable to Arsh and to be determined by the court for causing hurt and payable by offender to the victim or his heirs

Hurt is defined as and means causing of pain, harm, disease, infirmity, injury or impairing, disabling, dismembering any organ of the body or part thereof without causing death. It is typed on the basis of part of body involved and manner of infliction, each having further subtypes. (Tables 4.2 & Fig 4.2)

Killing of human being is a serious crime. It can occur during one's life from intra-uterine to extra-uterine unto the end point. Law divides killing into three types:

- Killing of human fetus, also called **miscarriage**
- Killing of self, also called **suicide**
- Killing of another human being, also called **homicide**.

Killing of fetus is evacuation of pregnant uterus. It may occur accidentally as spontaneous, induced therapeutically on medical grounds or by criminal means. Criminal miscarriage had been regarded as one of the most heinous crime in the early medico-legal codes. Therapeutic abortion, on the other hand, when performed in good faith for the sole purpose of saving life of mother used to be considered as the only justified reason for termination of pregnancy. The period of gestation is an important deciding factor. The attitude of society towards therapeutic abortion is changing dramatically.

Table 4.2:

Classification of hurt		
Type	Subtype	Description and extent of damage
Itlaf-i-Udw		
Itlaf-i-Salahiyyat-i-Udw		
Shajjah		Hurt on the head or face which does not amount to Itlaf-i-Udw or itlaf-i-Salahiyyat-i-Udw.
	Shajjah-i-Khafifah	Hurt without exposing of bone.
	Shajjah-i-Madihah	Exposing of bone without its fracture.
	Shajjah-i-Hashimah	Fracturing of bone without displacement.
	Shajjah-i-Munaqqilah	Fracturing of bone with displacement.
	Shajjah-i-Ammah	Fracturing of bone and the wound touching the membranes of brain
Jurh	Shajjah-i-Damighah	Fracturing of bone with rupturing of the brain membranes.
		Hurt on part of the body other than the head and face bearing mark of wound which may be temporary or permanent.
	Jaifah	Hurt extending to the body cavity of the trunk.
	Ghayr-Jaifah	Hurt not amounting to Jaifah.
	Damiyah	Rupturing of the skin with bleeding.
	Badiyah	Cutting of the flesh without exposing the bone.
	Mutalahimah	Lacerating of flesh.
	Mudihah	Exposing of bone.
	Hashimah	Fracturing of bone without displacing it.
	Munaqqilah	Fracturing of bone with its displacement.

BODY HURTS	
PART INVOLVED	MANNER OF CAUSATION
Itlaf-i-uwad	Negligent driving
Shajjah	Negligent act
Itlaf-i-Salahiyat-i-uwad	Mistake (khata)
Jurh { Jaifah	Poisoning
Ghayr Jaifah	
Damiyah	
Badiyah	
Mutalahimah	
Mudihah	
Hashimah	
Munaqqilah	
Khafifah	
Madihah	
Hashimah	
Munaqqilah	
Ammah	
Damighah	

Fig 4.2: Classification of body hurts

Extent of provision of abortion services in the western countries is now considered as an index of community's stage of civilization.

Crime of **infanticide** exists in U.K having reduced punishment for a guilty mother only, compared to killing by another. Pakistan penal code is silent about it. Instead protects the new born child by prohibiting its secret burial or otherwise disposal whether dies before, during or after birth. Further, law after its conformity with Islamic principles now takes into consideration two stages of fetal gestation making the offence of miscarriage more serious, when done at a later stage of pregnancy.

In U.S.A. till 1973, the statute law had declared performance of criminal miscarriage unlawful. Decision of Supreme Court has radically changed it by new principles giving importance to three stages of fetal gestation and accepting the will of concerned individuals in this matter transferring authority to them. (Table 4.3)

Table 4.3:

Period of gestation and authority for decision	
Period	Authority for decision
First, 13 week	Pregnant women and her physician
Second, onward to viability*	Physician, in the interest of pregnant woman's health **
Third, after viability	Physician, only to preserve pregnant woman's life

* 28 weeks gestation (occasionally earlier as 24 weeks)

** Taking into consideration her age, emotional health, family size and general well being

Abortion Act 1976 of U.K has legalized performance of abortion, laying conditions for its as under:

- A person shall not be guilty of an offence under the law when a registered medical practitioner terminates a pregnancy, if two registered medical practitioners are of the opinion formed in good faith that
 - (i) Continuance of the pregnancy would involve risk to pregnant women's life or injury to her physical/mental health or her existing children greater than if the pregnancy were terminated
 - (ii) There is a substantial risk that if the child were born, it would suffer from such physical or mental abnormalities as to be seriously handicapped.
- Opinion of two registered medical practitioners shall not apply to the termination of a pregnancy by a registered medical practitioner in a case where
 - (i) He is of the opinion formed in good faith that the termination is immediately necessary to save the life or
 - (ii) Prevent grave permanent injury to the physical or mental health of the pregnant women.

Killing of self is an act of taking one's own life intentionally and voluntarily. Attempts have been divided into degrees explaining circumstances. (Table 4.4)

Table 4.4:

Category	Circumstances
Degree 1.	Deliberate (planned) - premeditated self murder
Degree 2.	Impulsive (unplanned) -under great provocation
Degree 3.	Accidental (intention to die is low) - person puts his life voluntarily into jeopardy.
Degree 4.	Circumstances of lack of capacity for intention - psychotic or intoxicated
Degree 5.	Self-destruction due to self-neglect - ignoring medical instruction
Degree 6.	Justifiable suicide - self-destruction due terminal illness

Suicide is a complex phenomenon having medical, social, ethical and philosophical

implications. Under religion codes of Jews, Christians and Muslims, it is prohibited. Starting from middle Ages, society first used canonical and later criminal law in its fight against suicide. Traditionally, it was necessary to assign blame for every death either to God (natural death), or to man (homicide or suicide).

In U.K., it was designated as a special crime punishable by mutilation, sanction on place or manner of burial, forfeiture of property or censure of family. The last of penal statutes have since 1961 been repealed and suicide is no more a crime. In U.S.A., with the exception of some states, suicide was never a crime through statute, though it was considered as such under the common law. In Pakistan attempted suicide is a crime punished with imprisonment.

In most countries, it is now regarded less as a crime and more as an unfortunate consequence of mental illness and social disorganization, yet an undercurrent of social condemnation persists.

Killing of another human being (Qatl) is either **culpable** or **non-culpable**. *Culpable-homicide* deserves blame and according to law, has four types; **Qatl-i-Aind**, **Qatl-i-Shibh-i-Amd**, **Qatl-i-Khata** and **Qatl-bis-Sabab** and has taken cognizance of intention and circumstances surrounding culpable homicide. *Non-culpable*

homicide is without blame, further divided into **justifiable** and **excusable**.

Euthanasia is a special type of mercy killing of a human being, who is suffering from a painful and incurable disease. It is controversial killing and has not so far been taken cognizance by law courts being legal or illegal.

Plato first advocated the practice of euthanasia under Roman emperor. It is also claimed that in ancient Marseilles, authorities used to be approached to order euthanasia or direct medical authorities to stop medical treatment. There are examples in western world, in which parents and guardians approached law courts with the request to issue directive to the medical authorities to switch off the respirator because of vegetative state of the patient.

Pace of life now has picked so much during the last few decades that the values like time and money have taken over the idealistic value of reverence and veneration. Important question is whether the medical profession should be allowed to practice euthanasia independently in the interest of the patient or his family. It is a highly complicated issue and it will not be resolved in the near future, because of socio-cultural and religious traditions.

Euthanasia has recently been legalized in Australia but such a step is still considered unpleasant and unethical in most part of the world. (Table 4.5 & Fig 4.3)

Table 4.5:

Types of killing and their description

Type	Subtype	Description and extent of damage
A. Miscourage		Killing of human fetus by evacuation of pregnant uterus
	Isqat-e-haml	Killing of child whose organs has not been formed, without good faith for the purpose of saving life of the mother or providing necessary treatment
	Isqat-e-janin	Killing of child whose limbs or organs have been formed without good faith for the purpose of saving the life of the mother
B. Suicide		killing of self by an act of taking one's life voluntarily and intentionally
C. Homicide		Killing of a human being by another human being
	Culpable homicide	Killing of a human being having a blame
	Qatl-i-amd	Killing of specific human being or another with intention and knowledge of causing death.
	Qatl shibh-i-amd	Killing of human being with intention only to harm, but the death occurs which is unlikely.
	Qatl-i-khata	Killing of human being without intention to kill or harm, but death occurs by mistake of act or fact.
	Qatl bis-sabab	Killing of human being without intention to cause harm or death, but death occurs during the course of an unlawful act.
	Non-culpable homicide	Killing of human being without having a blame
	Justifiable homicide	Killing of human being in pursuance of law. Example judicial hanging and killing by police during suppression of riots
	Excusable homicide	Killing of human being in excusable circumstances example death in self defense

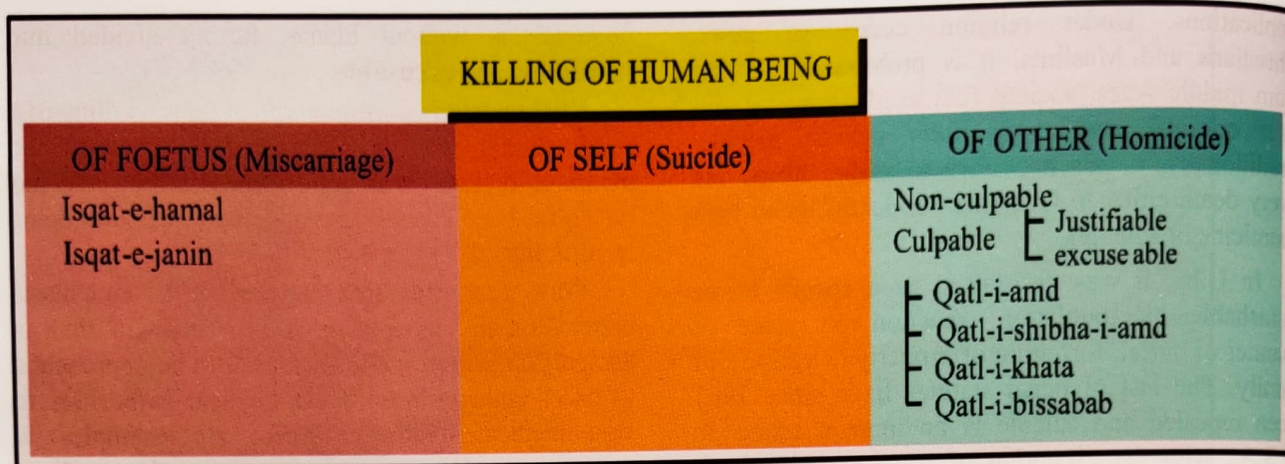


Fig: 4.3: Classification of Killing

Offence of rape has since been repealed, replaced with that of two offences of **Zina** and **Zina-bil-jabiar** and introducing different scales of punishments when committed by Muslims and individuals of other religion by enacting **Hadood ordinance 1976**. (Table 4.6)

Table 4.6:

Differentiation between zina and zina-bil-jabiar

Offence	Definition
Zina	Willful committing of sexual intercourse without being validly married to each other*
Zina-bil-Jabar	Committing of sexual intercourse with a woman or man** without being married, against will and consent of the victim*

*Penetration constitutes sexual intercourse for offence of Zina.

**When woman commits Zina-bil-Jabar

It has complicated the situation and its grasps require proper understanding of previous offence of rape, zina and zina-bil-jabar. Offence of rape was committed exclusively by a man with a woman against her will and consent. On the other hand offences of zina and zina-bil-jabar under the new law are willful committing of sexual intercourse by man as well as by woman, who are not validly married to each other, even with consent of partner and more heinous without consent of the partner. Punishment for Muslims, who are married and get involved, is severer and for this purpose terms of **Hadd** and **Muhsan** have been included:

- **Hadd** means punishment ordained by Holy Quran or Sunnah.
- **Muhsan** applicable to Muslim adult man and Muslim adult woman and means:

- A Muslim adult man and not insane, who has had sexual intercourse with Muslim adult woman and not insane, at the time he had sexual intercourse with her was married to her
- A Muslim adult woman and not insane, who has had sexual intercourse with a Muslim adult man, at the time she had sexual intercourse with him, was married to him.

Above stated is the current legal situation. Majority of the cases fall amongst normal healthy individuals and gets investigated in accordance with prevailing situation. But human sexual behavior during sexual intercourse is highly complicated and continues to remain confidential affair especially so when crime is involved. Besides, there is varied individual's requirement depending upon his mental disposition. Its relationship with sexual assault depends upon understanding and analysis of essential factors like **necessity of sexual indulgence, normal and socially accepted manner and abnormal and socially unacceptable behavior**:

- **Necessity of sexual indulgence** in both sexes is an intrinsic desire of variable intensity, which is compulsive and reparative. It must be fulfilled at intervals.
- **Normal and socially accepted manner** is difficult to define. In a medico-legal conference at Boston University, it was as decided that normal sexual activity may be defined as, "an adult's sexual expression with an adult of the opposite sex with mutual respect, tenderness and love." Socially accepted manner though varies at the individual level because of personal, traditional, racial and social differences amongst people, yet heterosexual

indulgence in **natural way** i.e. **sexual intercourse per vagina** is essential for procreation of the human race and is therefore, considered acceptable to fulfill this necessity. All religious codes accept these principles and all societies have legalized them under specific conditions of marriage and family laws. Marriage, therefore, has been accepted as the right way of having sexual intercourse with the partner of opposite sex. Sexual intercourse of normal type is the most important factor in a functioning marriage. Inability on the part of either spouse to consummate marriage enables the courts

to declare the marriage null. Consummation depends upon successful coitus.

- **Abnormal and socially unacceptable behavior** has not been a fully studied topic, being an extremely personal, private and confidential affair and there is a small percentage of people, who adopt **unnatural** or **perverted way**. No accurate statistical data is available. Unnatural sexual practices that are met in society involve both males as well as females. **Homosexuality** is on the top of the list. (Fig 4.4)

SEXUAL INDULGENCE (Of humans)		
NATURAL WAY (Per-vagina)	UNNATURAL WAY (Other way)	PERVERTED WAY
Marriage (After marriage)	Sodomy (Per-anal cannal)	Sadism + Homosexuality
Zina (Unlawful, without marriage)	Bestiality (Sex with animals)	Masochism + Voyeurism
Incest*	Lesbianism (sexual activity between women)	Paedophilia + Exhibitionism
		Trans-sexualism + Necrophilia
		Fetishism + Transvestism

*Sexual intercourse between blood relation

Fig 4.4: Classification of Sexual practices

Besides, a very small percentage of persons, who due to their acute psychological need, transgress beyond usual sexual practice of foreplay and intercourse and become abnormally aggressive during the act. It may result in trauma to the partner and even death, which fortunately is rare. But when it does occur, creates sensation. This phenomenon should be recognized, because the catastrophe is the result of the complicated blend of many different sexual deviations with one type dominating over others. The most common combination is **sadomasochism**, **sadism** being primary and dominant trait. (Photo 4.1 & Table 4.7)



Photo 4.1: Death during aggressive sexual foreplay and intercourse

Table 4.7:

Sexual perversions with definitions

Perversion	Definition*
Sadism	Sexual pleasure from acts of cruelty to partner of opposite sex
Masochism	Sexual pleasure from pain/injury inflicted by partner of the opposite sex
Homosexuality	Sexual stimulation and gratification by partners of the same sex
Lesbianism	Sexual stimulation and gratification after consent between two females
Transsexualism	Desire to adopt the opposite sex
Transvestism	Sexual gratification derived by wearing dress of opposite sex
Pedophilia	Sexual love with prepubescent child
Voyeurism	Sexual gratification by looking at naked picture or body of the opposite sex
Exhibitionism	Sexual pleasure by exposing sex organs to the members of the opposite sex
Bestiality	Transference of object of sexuality from human beings to animals
Necrophilia	Desire to use dead body for sexual pleasure
Fetishism	Transference of sexuality object from human beings to belongings of opposite sex

* To qualify as perversion, the desire should be morbid, taking precedence over desire for normal sexual intercourse

Sexual offenders, who are otherwise normal, but deteriorated morally, should be punished, rather severely to prevent illegal sexuality in the society.

Marriage laws have developed through ages starting with **common law union** to the present laws of marriage. Though there are international differences due to culture and religion, yet basic concept in the union of marriage is the same. Every society prescribes requirements of a good marriage, which are generally reflected in the customs. Essential criterion for a good marriage is that it should take place between a male and a female, both having appropriate ages and they should not have blood relation. These principles have been accepted by civilized societies. Pakistan is no exception. Important prevalent laws are:

- **Child Marriage Restraint Act 1929**
- **Dissolution of Muslim Marriage Act 1939**
- **Muslim Family Laws Ordinance 1961**

Child Marriage Restraint Act 1929 is to protect children by prohibiting their marriages at an early age before the attainment of majority. The law prescribes punishment to parents or guardians who arrange or promote child marriage and further directs that once such a marriage occurs, it remains valid till the attainment of the puberty of the child.

Dissolution of Muslim Marriage Act 1939 spells grounds for decree for dissolution of marriage amongst Muslims. Aggrieved party has to move the court of law for redress and place grounds for separation. The most important ground for dissolution of marriage is sexual deprivation of wife resulting from non availability of husband or his failure to perform sexual intercourse. (Table 4.8)

Table 4.8:

List of grounds for the dissolution of marriage

1. Husband's whereabouts unknown for four years
2. Husband's failure to provide maintenance for two years
3. Husband imprisoned for seven years
4. Husband's failure to perform marital obligations for three years
5. Husband's impotence since married
6. Husband suffering from insanity, leprosy or virulent venereal disease for two years.
7. Repudiation of marriage by wife after attainment of majority.
8. Husband's cruelty towards wife by way of:
 - (a) Physical or psychological violence
 - (b) Associating with women of ill repute
 - (c) Forcing her to lead immoral life
 - (d) Obstructing her from religious practices
 - (e) Disposing her property
 - (f) Not treating her equally in the presence of other wife/wives

Muslim Family Law Ordinance 1961 is a resent law, which provides for registration of existing marriage. It further permits husband the privilege of second marriage on certain grounds such as sterility or physical infirmity for conjugal relations of existing wife. Insanity of existing wife is also a ground.

Industrial worker compensation,

which involve use of large machines and chemicals having potential for causing injury to the body of worker. Similarly, toxic material may leak out into the environment affecting adversely the health of the worker and residents of the locally. Recognition of cause-effect relationship helps devise preventive measure for adoption in future and its medical certification serves the cause of justice to permit proportionate compensation to the worker.

Common law torts, laid principles to provide compensation to private individuals for losses suffered through conduct of others involving important issue of presence or absence of fault. (Table 4.9)

Table 4.9:

Principles of common law torts

1. Plaintiff* has a right to be free from physical and mental injury
2. Defendant** has a duty to the plaintiff to conform to a standard.
3. Breach of duty by the defendant.
4. Breach of duty resulting into damage to the plaintiff.
5. Determination of damage in terms of money

* Party who sues in the court of law.

**Person sued or accused in the court of law.

Intentional torts, on the other hand is criminal injury requiring action by the state in the form of punishment and **Negligence** without due regard for others safety resulting in injury is no more routinely applicable.

Modern laws of compensation of factory worker are based on the concept of **insurance** against injury to body or health of the worker and ensure prompt and proportionate cash benefits for any kind of worker's disability whether temporary or permanent caused due to accident. The permanent disability is further classed as total or partial.

Important laws, which are related with compensation to industrial worker, are **Workman's compensation Act 1923** with **compensation Rules 1961** and **Employee Social Security Ordinance 1965**.

Workman's Compensation Act 1923 with compensation Rules 1961 provides for compensation to the worker for any injury or disablement's occurring both due to accident and environment at place of work. An injured worker has two alternatives. He may either proceed under Workman's Compensation Act, or he may sue his

employer for damages in any civil court in which case he forfeits his rights under the Act. Injuries at the place of work resulting in total or partial permanent disablement (**Table 4.10**) or occupational disease (**Table 4.11**) have been enlisted in Schedules I and III respectively.

Table 4.10:

List of injuries of permanent disablement

Description of injuries	Percentage loss of earning capacity
A. Permanent Total disablement	
Loss at the level both hands or amputation at higher sites	100
Loss of one hand and one foot	100
Double amputation through leg or thigh or amputation through leg of one side and loss of the other foot	100
Loss of sight to such an extent as to render the victim unable to perform any work for which eyesight is essential	100
Very severe facial disfigurement	100
Absolute deafness	100
B. Permanent partial disablement	
(i) <i>Amputation cases -- Upper limbs (each limb)</i>	
Amputation through shoulder joint	90
Amputation below shoulder with stump less than 8 inches from tip of <i>acromion</i>	80
Amputation from 8 inches from the tip of <i>acromion</i> to less than 4 1/2 inch below the tip of <i>olecranon</i> is essential	70
Loss of hand or of the thumb and forefingers of one hand or amputation from 4 1/2 inch below the tip of <i>olecranon</i>	60
Loss of thumb	30
Loss of thumb and its metacarpal bones	40
Loss of forefingers of one hand	50
Loss of three fingers of one hand	30
Loss of two fingers of one hand	20
Loss of terminal phalynx of thumb	20
(ii) <i>Amputation cases -- Lower limbs (both limbs)</i>	
Amputation of both feet resulting in end-bearing stumps	90
Amputation through both feet proximal to <i>metatarsophalangeal joint</i>	80
Loss of all toes of both feet through <i>metatarsophalangeal joints</i>	40
Loss of all toes of both feet proximal to the proximal <i>interphalangeal joint</i>	30
Loss of all toes of both feet distal to proximal <i>interphalangeal joint</i>	20
(iii) <i>Amputation cases -- Lower limbs (each limb)</i>	
Amputation at hip	90
Amputation below hip with stump not exceeding 5 inches in length from the tip of greater trochanter	80
Amputation below hip with stump exceeding 5 inches in length from the tip of the greater trochanter	70
Amputation below mid-thigh to 3 1/2 inch below knee	60
Amputation below knee with stump exceeding 3 1/2 inch but not exceeding 5 inches	50
Amputation below knee with stump exceeding 5 inches	40
Amputation of one foot resulting in end-bearing stump	30
Amputation through one foot proximal to <i>metatarsophalangeal joint</i>	30
Loss of all toes of one foot through <i>metatarsophalangeal joint</i>	20
C. Other injuries	
Loss of one eye without complications, the other being normal	40
Loss of vision of one eye without complications or disfigurement of eye ball, the other being normal	30

Table 4.11:**Occupational diseases**

Occupational diseases	Employment
Anthrax Employment	Any employment involving: a) Handling of wool, hair, bristles or animal carcasses including hides, hoofs and horns b) Working with animals infected with anthrax c) Loading, unloading or transportation of merchandise
Compressed air illnesses	Any process carried on in compressed air
Leads	Any process involving the use of lead
Nitrous fumes	Any process involving the use of nitrous fumes
Phosphorus	Any process involving the use of phosphorus
Mercury	Any process involving the use of mercury
Benzene	Any process involving the use of benzene
Chrome	Any process involving the use of chrome
Arsenic	Any process involving the use of arsenic
Pathological manifestations due to	
Radium	Any process involving exposure to the action of radium
Radioactive substances	Any process involving exposure to the action of radioactive substances
X-rays	Any process involving exposure to the action of X-rays
Primary epitheliomatous cancer of skin	Any process involving the handling of tar, pitch, bitumen, mineral oil, paraffin or compounds of these substances
Silicosis	Any process involving the grinding, cleaning, fettling, casting and crushing of Stones

Temporary disablement means disablement of temporary nature, which reduces the earning capacity of a workman in employment in which he was engaged at the time of the accident

Permanent disablement means disablement which reduces his earning capacity in every employment which he was capable of undertaking at the time of accident: provided that every injury specified in the Schedule I shall be deemed to result in permanent partial disablement.

Total disablement means disablement whether of a temporary or permanent nature¹ as incapacitates a workman for all kinds of work, which he was capable of performing at the time of the accident. Permanent total disablement shall be deemed to result from:

- Permanent total loss of the sight of both eyes
- from any combination of injuries specified in Schedule I where aggregate percentage of the loss of earning capacity as specified in that Schedule against those injuries, amounts to one hundred per cent

Employees Social Security Ordinance 1965 provides for the insurance of both employer and employee and the scope of benefits have been made more liberal extending them even to dependents of the worker. The disability has been equated to

inability to engage in any substantial gainful activity because of any medically determinate impairment. The state, employer and employee all pay contributions to the social security fund to be utilized for workers benefit, (Table 4.12) when earnings are stopped.

Payment of the benefits to the worker is through the Social Security Institution having a medical advisor, medical boards and many medical practitioners. It can safely be stated that introduction of social security laws has made extensive improvements in medico-legal matters concerning an industrial worker by replacing the ancient rule of Common law tort to most modern laws of Social Security. Legislation has replaced judicial decisions, which has permitted more satisfactory handling of medico-legal issues evolving from industrialized, urbanized and technologically advanced society of modern man. Improvements have made medical issues as principle concern from inception of insurance to payment of claims for disability or death. It means that medicine has moved from an inferior position to a superior position and further the authority to make decision in such cases involving medical issues has moved from lay courts to expert administrative agencies having medical specialists. It has also resulted in standardization of claims.

Table 4.12:*Employment benefits of the worker*

Benefit	Legal Definition
Sickness Benefit	A secured person who is certified to be incapable of attending to his work on account of sickness shall be entitled to receive sickness benefit throughout the period of sickness.
Confinement	Labor resulting in the issue of a living child or labour after 26 weeks of pregnancy resulting in the issue of a child, whether alive or dead.
Maternity Benefit	A secured woman shall be entitled to receive maternity benefit as certified by a medical practitioner and such benefit shall be paid for all days on which she does not work for remuneration during a period of twelve weeks, of which not more than six weeks shall precede the expected date of confinement.
Disablement	Condition caused by an employment injury which has permanently reduced or is likely to reduce permanently a secured person's earning capacity. Disablement shall be minor when the loss of earning capacity is less than twenty percent, partial when the loss of earning capacity ranges from twenty one percent to sixty-one percent and total when the loss of earning capacity is in excess of sixty-six percent.
Injury Benefit	A secured person shall be entitled to receive injury benefit in respect of any day, other than the first three days, including the day on which, as a result of an employment injury, to be incapable of work, but for not more than one hundred and eighty days.
Disablement Pension	A secured person who sustains total or partial disablement shall be entitled, upon the expiration of his entitlement to injury benefit, to receive disablement pension, according to the degree of disablement determined.
Employment injury	Personal injury to a secured person caused by an accident or by such occupational disease arising out of and in the course of his employment.
Disablement Gratuity	(i) A secured person who sustains minor disablement shall be entitled to a disablement gratuity for different degrees of disablement as may be fixed by Government by notification, in consultation with the institution. (ii) Where a person receiving disablement pension ceases to suffer from total or partial disablement but continue to suffer from minor disablement he shall, on the termination of his disablement pension, be entitled to disablement gratuity under this section.
Death Grant	On the death of a secured person entitled to receive injury benefit, sickness benefit or medical care at the time of death, the surviving widows/widower/the person who provided for the funeral shall be entitled to a death grant equal to the daily rate if sickness benefit multiplied by thirty, but in no case less than five hundred rupees.

CHAPTER 5

5. Personal identity

Recognition of individuality means Personal identity. Accepted particulars for this purpose are individuals/ father's name, age, sex, height, weight and residential address. Proof of personal identity is a legal requirement for all administrative purposes like admission into schools, colleges and universities and also for seeking employment, passport and driving or fire-arm license. In law enforcement, no complaint against another person is entertained and investigated by police without confirmation of accused and applicant's personal identity. Above stated particulars are routinely mentioned along with two permanent identity marks like scar or mole and it was considered sufficient. Introduction of computerized national identity card (CNIC) bearing facial photograph, permanent identity mark and signature or thumb impression of the holder has standardized method of personal identification.

Cases of personal identity during law enforcement investigation, which occasionally create problem are person without CNIC or willfully withheld, unconscious victim of road accident and absconding soldier. It may also becomes a problem in wanted criminal, lost memory patient, missed up baby in maternity ward and rarely in a case of impersonation. Only choice or method left to establish personal identity in such cases is to prepare written narrative i.e. full description of person including possible identity clues related to him after careful and meticulous physical examination. Police till recently had been preparing written narrative of person's description basing it on conventional methods, though are based on sound footing, yet have no medical background:

- **Anthropometry**, also called **Bertillon's anthropometric system**
- **Dactylography**

Bertillon's anthropometric system named after its originator was criminal investigation assistant in France. He observed that after the age of 21, an individual ceases to increase in size and most of his measurements such as length/ breadth of head, length of middle, index and little fingers and size of feet and toes could be used as clues to personal identity. According to him if 14 such measurements are collected, odd against any two persons having the same measurements is 1 to 286. His supporters

considered it almost an infallible method. Final method consisted of individual's descriptive data, which included color of skin, eyes and hair, shape of nose, ears, chin and identity mark on the body like mole, scar or tattoo, and 14 bodily measurements including standing and sitting heights. Method required extensive apparatus and time. (Fig. 5.1)



Fig. 5.1: Main sketches of Bertillon's anthropometric system

Dactylography is superior to the above method and is based on the study of patterns of ridges present on hand finger tips after taking of fingertip impressions, Chinese used thumbprint as an identity mark on seals many hundreds of years ago. In 1823, a Czechoslovakian physiologist **J.E. Purkinje** described them giving first classification. In 1885 **Henry Faulds**, Scottish physician recognized importance of skin ridges as an aid to personal identification and its possibility of using them in criminal investigation. In 1892, **Francis Galton** produced proper scientific work on the subject, which was later improved and elaborated by **Edward Henry**.

Personal identification from individual's fingerprints is a matter for fingerprint expert. Medical practitioner should have some knowledge of patterns of papillary ridges, which remain constant from birth to death and are not destroyed by desquamation of surface epithelium or by abrasive action of sandpaper. These ridges on fingertips form different patterns and expert study of fingertip pattern shows 150 ridge characteristics. It is the fingertip pattern and ridge characteristics, which are individual specific. So far there have been many classifications of fingertip patterns, but the most common and accepted classification includes four patterns i.e.

arch or **tented arch**, **loop** or **twinned loop**, **whorl** and **composite**. A very low percentage of individuals may have an additional **accidental** pattern. Accuracy of this method is because of type of fingertip patterns and their individual characteristics. Federal Bureau of Investigation in United States has over 30 million fingerprints on its files and none are alike. (Fig 5.2)

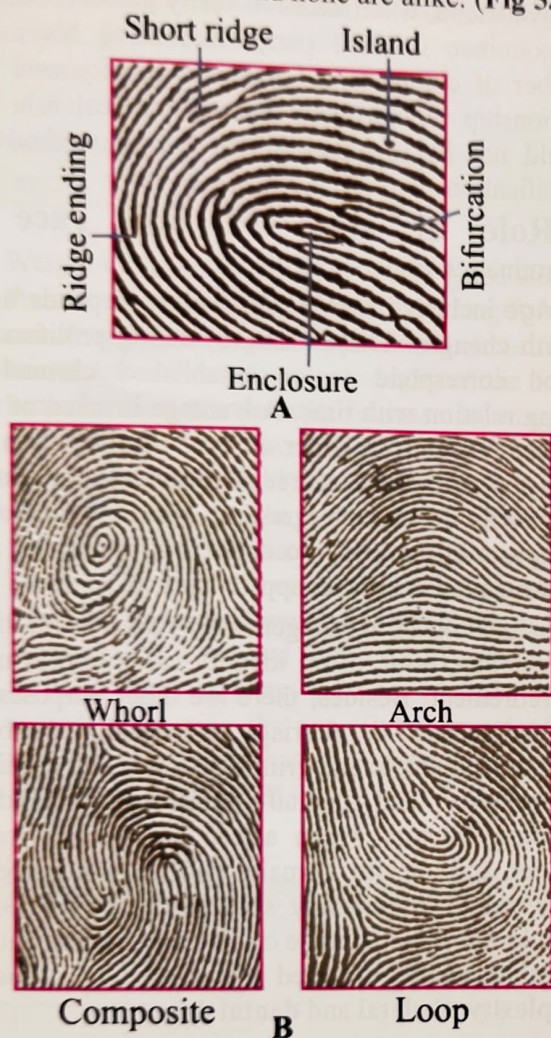


Fig 5.2: A. Papillary ridges' characteristics B. Four fingertip pattern

In our country after an allegation of a crime and arrest of a person, prints of all five fingers are taken. Thumbprint is taken at the time of joining an employment and for issue of computerized identity card and passport. There are two methods of recording of fingerprints; plain and rolled, later is considered better.

Forensic medicine has since long been playing its role to resolve problems of police including determination of personal identity of unknown during investigation by law enforcement. Forensic medical

examiner may be approached and requested for advice to help in like cases:

- Harden skin of hands of dead body due to postmortem drying has difficulty of recording of finger prints. Skin should be rendered soft by application of oil and fingertip contour restored by injecting subcutaneous area bearing print with paraffin wax
- In case of de-gloving of epithelium, as generally happens in early decomposition, it should be carefully separated from underlying tissues sparing print and then spread on a slide and preserved between two glass slides after air drying.
- Preservation of whole hand, five fingers or even fingertips is undertaken by cutting at proximal joints and cut-portions preserved either in saturated saline or rectified spirit in separate containers having a label mentioning hand, finger or fingertip whether of left or right side.
- Basic principle applicable for establishment of personal identity of fresh unknown cases and decomposed, mutilated or burnt human's remains is location and utilization of individual's personal identity clues and those of his belongings.

Human bodies though appear similar, yet some of its body parts such as face, hands and feet are individuals specific. Other personal identity parameters are related to anatomy, physiology, pathology and even genetics. (Table 5.1)

Table 5.1:

Personal identity parameters	
Whole body	Age (height and weight) and sex
Body parts	(a) Face having specific shape of eyes, nose, lips, chin, cheeks, teeth, color of iris (b) Hands and feet bearing specific finger prints/tracings
Anatomy	(a) Primary at birth --no sex character (b) Secondary that appears later--sex characters and other degenerative changes like cataract/arcus senilis in eyes
Physiology	Gait, tone of voice and manner of speech
Pathology	Diseases—eczema/calcified fibroid
Genetics	Blood groups and other morphological character like Barr body

Related findings collected during physical examination depend upon physical condition of dead body whether fresh or otherwise and circumstance surrounding the case. They are present within body as a whole, human remains and belongings. Examples of various characteristics clues within body are facial features, color of skin, height, weight or any special

finding like webbed fingers and others in belongings are wristwatch, spectacles and head cap. All have a role in personal identity.

Compilation of personal identity data is a technical job, more suited to the medical personnel rather than police, being a part of descriptive protocol. Every case should be dealt carefully on its own merits, avoiding orthodox approach, as it prevents application of fresh knowledge. Problem may have to be discussed amongst involvement experts belonging to others specialties before starting work. Coordinated approach is better. There are two methods **Subjective** and **Objective method**.

Subjective method is applicable in fresh unknown, unconscious and unaccompanied road accident victims. Other possible cases are highly putrefied and burnt bodies in which facial identification and fingerprinting is not possible. Fresh ones present no difficulty in preparation of descriptive protocol. Physical examination of remains of putrefied and burnt bodies including belongings is subjected to search to isolate various tissues like hair, nails teeth and bones, which do not putrefy. These tissues are subjected to thorough wash to make them fit for physical inspection, microscopy and radiology for identification of their characteristics for matching. Non-biological material of interest in such cases is clothes and other belongings, which are subjected to physical inspection to note style of dress, identity marks of tailoring and laundry. During autopsy of fresh case, information may be very extensive and that of other during advanced putrefaction, gross mutilation and severe burns especially with parts missing, it is patchy and limited. Dried stains of blood and semen on clothes and other biological trace of human or animal origin that are not subjected to decomposition are extremely valuable to identify their sources of origin. It will be discussed as a separate topic under the heading of trace evidence.

Objective method is utilization of already collected data. It is analyzed to isolate individual's specific identity clue or character, which can act as a lead to personal identity. Exercise is based on the theory that a character having intimate association to a person, be it may in body of the person or his belongings, is sufficient to establish his identity. An example to illustrate this point is that the fattest, the shortest or the tallest boy/girl in a class does not

require additional clue or characteristics, even facial for his recognition.

Third party method used during forensic medical certification/autopsy is in-fact legal approach for identification of examinee. There is essentially two parties', medical examiner and examinee and relative/friend, when asked to verify personal identity of examinee is third party. Recording his name, number of computerized national identity card and relationship in certificate has no medical role and should not be included in the list of methods of identification.

Role of age, sex and race in determination of personal identity:

Age inclusive height and weight depends upon growth changes. These changes, during proliferative period correspond to an established chronology having relation with time. Advantage is taken of this record of events in order of time that age can be estimated with some degree of reasonable accuracy. Afterwards during retrogressive period, changes in most parts of the body do occur, but are erratic and age estimation is only an approximation.

Estimation of age is generally raised at the time of schooling, issue of an identity card, employment and retirement. Besides, there are other purposes of civil nature such as marriage and election for both voter and candidate and criminal nature like criminal responsibility and capital punishment including whipping. Factors which affect age are sex, race, nutrition and climate. Females end up in advance of males and it is generally seen that puberty ensues much earlier in hot climate of the East. Determination of age is mainly directed towards study of **body complexity, skeletal and dental data**.

Body complexity includes length, weight and morphological body:

- Length of fetus during intrauterine period may be fixed with near mathematical accuracy by direct measurement by **Hess's Rule**. It states that squares of months of gestation give the length of fetus in centimeters upto fifth month and after words, number of months should be multiplied by five, which shall give length of fetus in centimeters. Later increase of length during extra-uterine period occurs at puberty in males at thirteen to fourteen years of age. Increases in length during extra-uterine period become erratic and the scale is neither regular nor reliable. (Table 5.2)

Table 5.2:**Fetal length and morphological features at different ages**

Age	Length	Morphological
1 st month	1.25cm	Embryo formed showing limb buds
2 nd month	2.5cm	Head formed showing ears and hands
3 rd month	9 cm	Placenta formed, nails appearing
4 th month	15cm	Sex clear, hair appearing on head
5 th month	25cm	Weight 350-450g
6 th month	30cm	Weight 700-900g
7 th month	35cm	Weight 1.2-1.4kg
8 th month	40cm	Weight 1.5-2kg
9 th month	50cm	Weight 2.5-3.5 kg

- Weight of fetus is important. Fetus gains weight at the rate of one pound per month starting from fifth month onward and later appearance of ossification center has a role. Average weight of the fetus at birth is about six pounds. Increase in weight, till end of first year, is also at the rate of one pound per month. A child roughly doubles its weight in first six months and weight is three times at the end of first year. After this, rate of increase in weight also becomes erratic. However, the general tables of average lengths and average weights are available, indicating in a general way rate of growth. From forensic point of view, they are of little value as regards estimating the age. But they are of some use in indicating what is expected in a normal individual. (Table 5.3)

Table 5.3:**Relation of age with heights and weights**

Age	Male		Female	
	Height (in feet)	Weight (in Kgs)	Height (in feet)	Weight (in Kgs)
1	2.5	8.4	2.3	8.2
2	2.8	15.0	2.7	11.5
3	1.11	15.5	2.10	14.5
4	3.1	16.7	3.0	16.3
5	3.4	18.2	3.3	17.5
6	3.7	20.0	3.6	19.0
7	3.10	22.5	3.8	21.5
8	3.11	25.0	3.10	23.5
9	4.1	27.5	4.0	25.0
10	4.3	30.5	4.2	28.0
11	4.5	32.5	4.4	30.5
12	4.7	35.0	4.6	34.5
13	4.9	37.5	4.8	39.5
14	4.11	41.5	4.11	43.5
15	5.2	46.5	5.1	48.2
16	5.4	54.0	5.2	51.5
17	5.6	59.0	5.3	52.5
18	5.7	62.0	5.3	55.0

- Morphological changes are developmental and retrogressive in nature.

a) Developmental changes during intra-uterine period are appearance of facial features, growth of nail, hair on head and eyelashes, differentiation of sex and descending of testis. During extra-uterine period the changes are appearance of fine hair in the pubic region, deepening of voice and enlargement of testes and penis takes place. These changes later are followed by appearance of hair in axillae and finally hair begins to appear on the face in male. Appearance of fine hair in female is about one year earlier than male, first appearing in the pubic region and then in axillae followed by enlargement of breasts. A girl also starts to menstruate around thirteen years.

b) Retrogressive changes take place in both sexes. They are not reliable and act only as pointers for age. These changes externally are:

- Wrinkles about eyes and in front of the ears around 30 to 35 years
- Arcus-senilis in eyes around cornea, which begins to develop at about forty years or later but seldom becomes circular and complete before the age of sixty years. However, an arcus-juvenile is also known to occur.
- Hair color change like graying occurs around forty years. Graying of pubic hair practically never occurs before fifty years.
- Loss of elasticity and discoloration of skin of buttocks and abdomen
- Internal changes are atrophy of the uterus, brown atrophy of the heart and calcification of laryngeal and costal cartilages generally occurs after forty years of age. All give some indication that the body is of an elderly person.

Skeletal data for determination of age requires examination of the bones. Human skeleton develops from a number of separate centers of ossification and their growth. Development of centers of ossification and bone growth is very complicated. Some idea of its complexity may be gaged from the fact that there are about 806 centers of bone growth at eleventh prenatal week stage, at birth about 450 and adult skeleton has only 206 bones.

With the exception of bones in skull, all other bones of the skeleton are pre-formed in cartilage, which takes on the characteristic shape of the bone-to-be and is, in very fact, the matrix within which ossification will occur. A typical long bone for

example tibia, will have three centers or principal loci of growth:

- Mid-portion, the shaft or diaphysis and
- Two end-portions; an upper or proximal and lower or distal, the epiphysis.

These three, one diaphysis and two epiphyses, are the growth loci of the tibia. At either end, between diaphysis and epiphysis, is a plate of hyaline cartilage, which is the diaphyseo-epiphyseal zone. It is here that growth actually occurs, and it is here that epiphyseal union occurs.

Histological examination of the ends of long bones in the earlier age and morphological examination of them at the later stage are the choices of examination for the determination of age. (Photo 5.1)

Reliable estimation of age is based on study of long bones of limbs (arm and shoulder, leg and hip) and skull bones including mandible. In long bones of limbs, appearance of primary centers of ossification and their growth with appearance of secondary

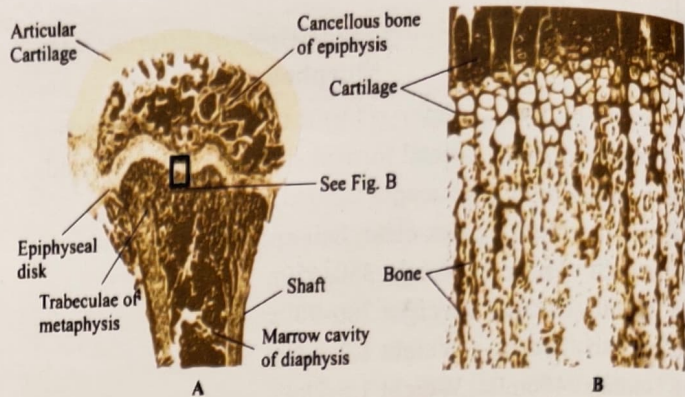


Photo: 5.1: *Photographical view of a longitudinal section through the upper end of a growing long bone showing diaphyseo-epiphyseal relationships A under low power and B under high power*

centers of ossification and their growth and finally union of epiphysis with diaphysis is the index unto the attainment of twenty-fifth year of age. (Fig. 5.3 to 5.6 & Photo.5.2)

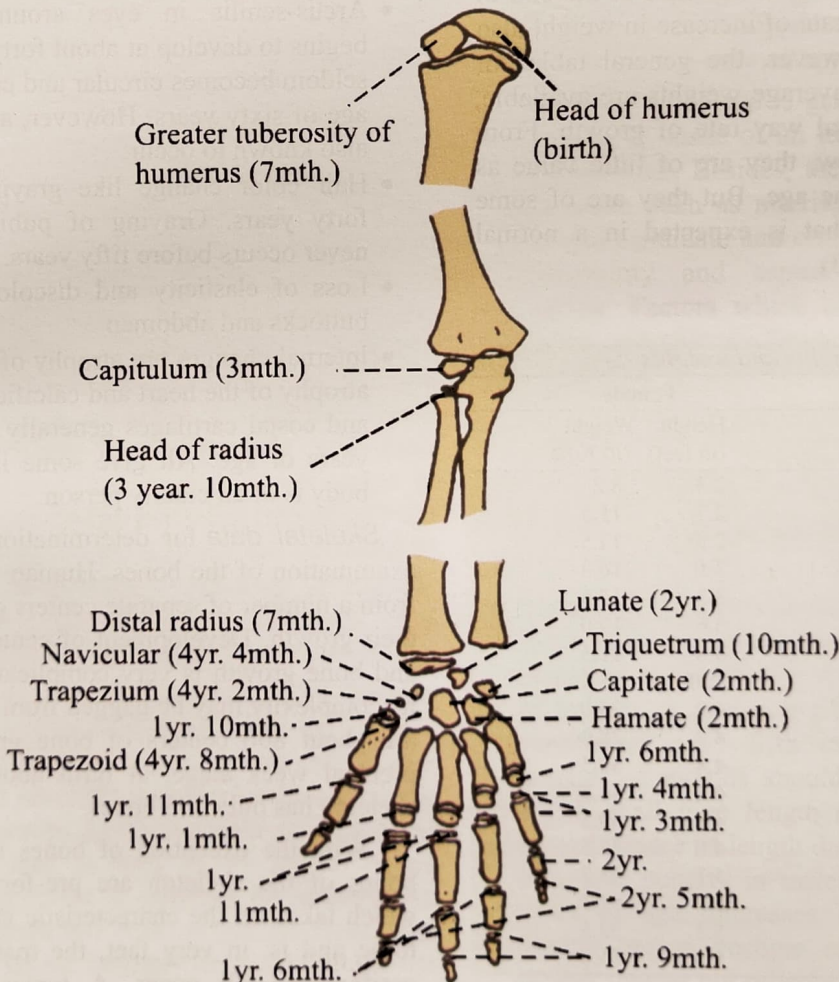


Fig 5.3: *Bones of upper limb showing appearance of centers of ossification upto the age of five years.*

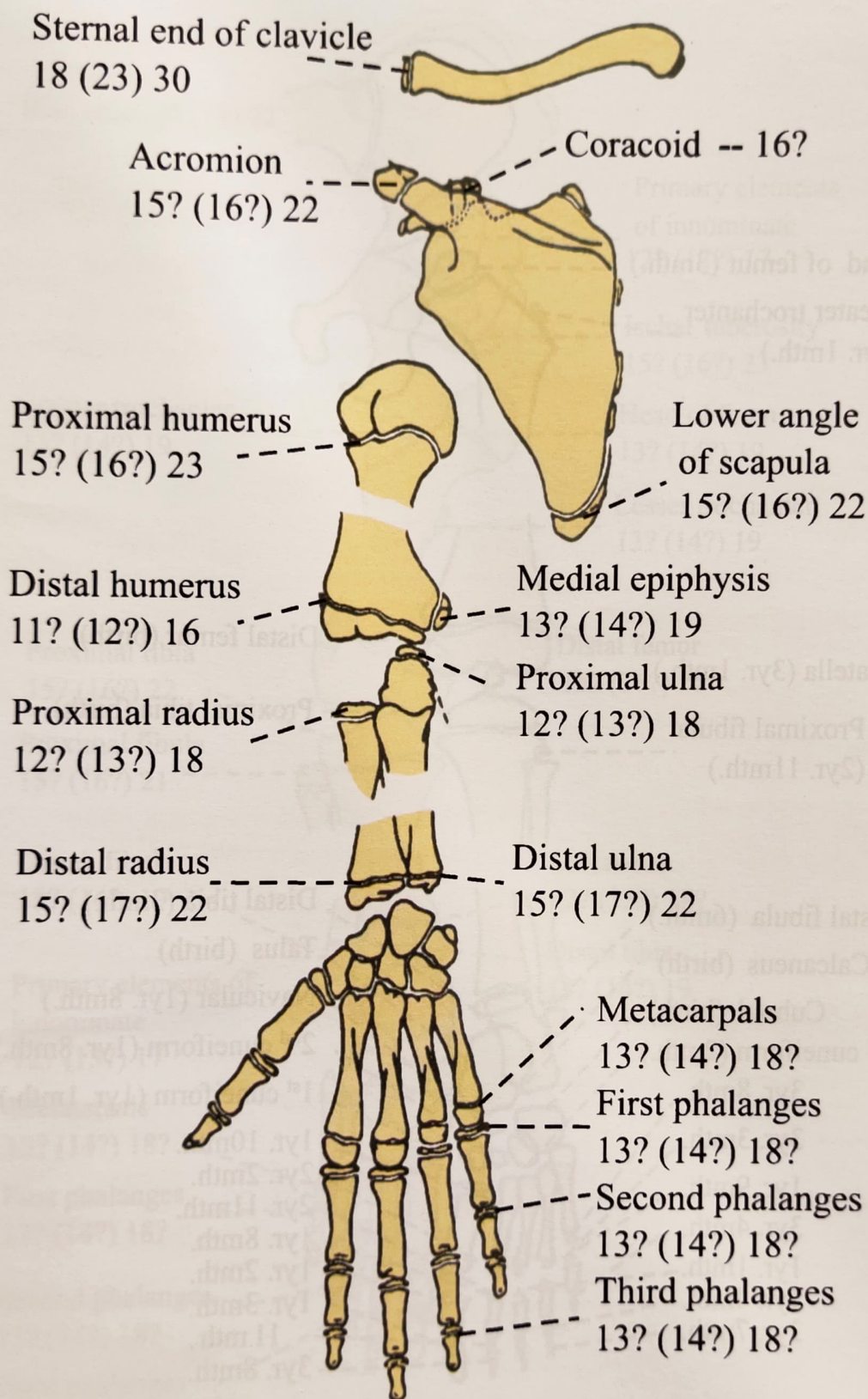


Fig 5.4: Bones of upper limb showing location and ages of unions of epiphyses. Of the three, earliest is age of union in female, second is age of union in male and next is average age of union

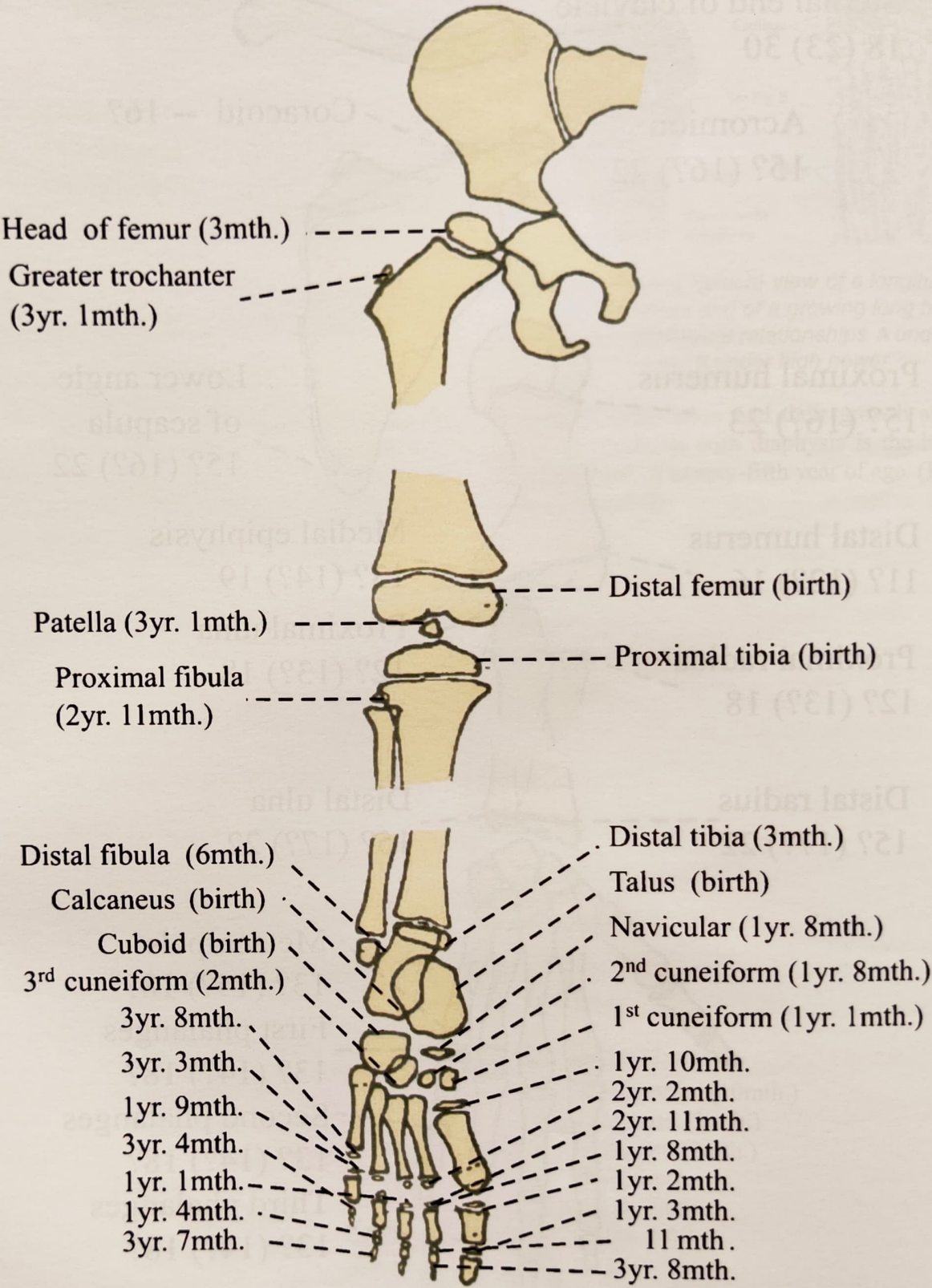


Fig 5.5: Bones of lower limb showing appearance of centers of ossification unto the age of five year

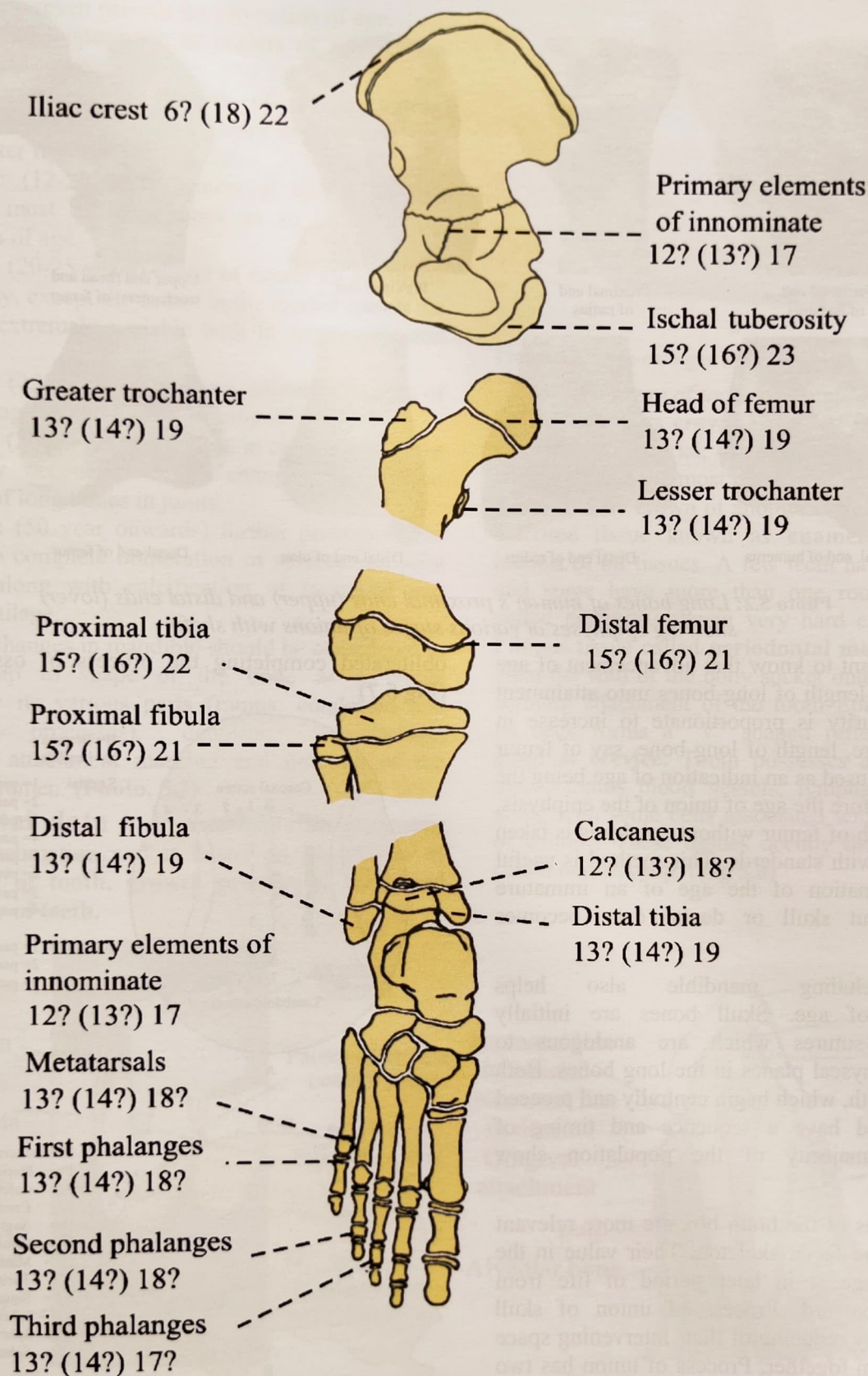


Fig 5.6: Bones of lower limb showing location of epiphyses and ages unions. Of the three, earliest is age of union in female, second is age of union in males and next is average age of union



Photo 5.2: Long bones of human's proximal ends (upper) and distal ends (lower) showing epiphyses at various stages of unions with shafts

It is important to know that advancement of age and increase in length of long bones unto attainment of age of maturity is proportionate to increase in height. Therefore, length of long bone, say of femur by itself can be used as an indication of age being the most useful. Before the age of union of the epiphysis, maximum length of femur without epiphysis is taken and compared with standards. This method is useful when the estimation of the age of an immature skeleton without skull or dental data, becomes necessary.

Skull including mandible also helps determination of age. Skull bones are initially separated by sutures which are analogous to epiphyseo-diaphyseal planes in the long bones. Both are loci of growth, which begin centrally and proceed peripherally and have a sequence and timing of union, when majority of the population show complete union.

Cranial sutures of the brain box are more relevant than those of the facial skeleton. Their value in the estimation of age is in later period of life from thirtieth year onward. Process of union of skull sutures begins by reducing of their intervening space and uniting them together. Process of union has two progressions i.e. from inner vault to outer vault and along the lines of sutures. Skull sutures finally get

obliterated completing the process of ossification. (Fig 5.7)

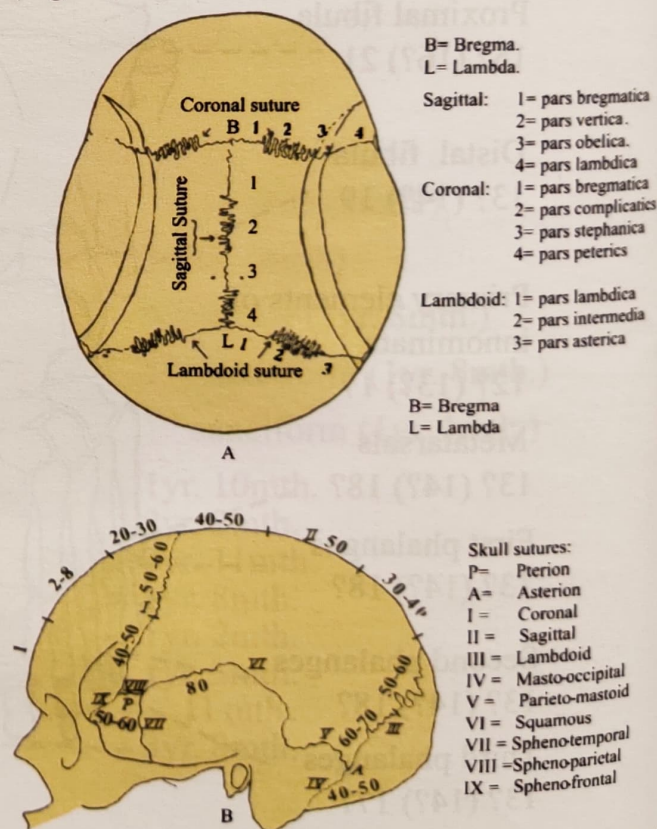


Fig 5.7: Cranial vault sutures. A. Subdivision. B. Ages closure

Krogman reviewing skeletal development divided changes into seven periods for estimation of age:

Period 1: on appearance of centers of ossification from birth to 5th year upon

Period 2: on further growth of above centers, appearance of additional secondary centers and size of the center from 5th to 12th year.

Period 3: (12-20 years) union of epiphysis with shafts in most of long bones as an indicator for estimation of age.

Period 4: (20-25 years) union of nearly all epiphysis in the body, except the center in the medial end of the clavicle (extremely variable both in appearance and union)

Period 5: (25-36 years) beginning, extent of closure of coronal, sagittal and lambdoid sutures.

Period 6: (36-50 years) progress in closure of sutures and early degenerative age changes in articular surfaces of long bones in joints.

Period 7: (50 year onwards) further process of the closure to complete obliteration of sutures and joint change, along with calcification of laryngeal and costal cartilage.

Age changes in mandible should be considered in relationship to shape of the bone as a whole especially its various parts (ramus, condoloid and coronoid processes), dentition, alveolar ridge, muscular attachment marking and position of the mental foramen. (Photo. 5.3)

Dental data is another important parameter for age estimation and is based on knowledge of **structure of tooth, growth process of teeth and wear-tear of teeth.**

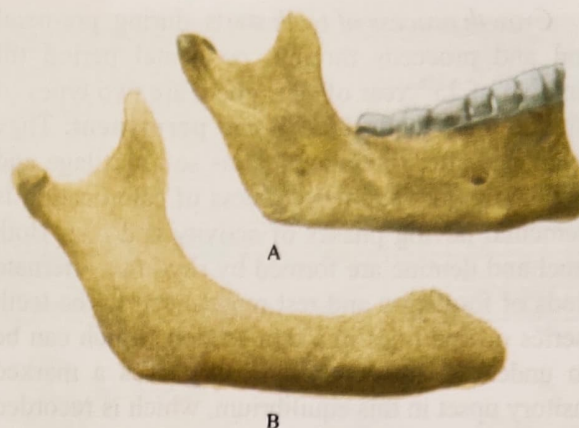


Photo.5.3: Age changes in mandible. A. Adult. B. Old ead

Structure of tooth is composed of **dentine** having two parts **crown** and **root**. Dentine is highly mineralized material, embedded in bony sockets of both jaws and the most durable of all body tissues. It is covered by crown of another extremely and highly calcified tissue known as **enamel**, which is the hardest of all tissues. A few teeth have a single root and some have more than one root. A substance called **cementum** again very hard covers all roots. Fibrous tissue called **periodontal membrane** passes from the wall of the bony socket onto the cementum forming attachment of the tooth. Epithelium around its neck forms a "V" shaped reflection is called **gingival crevice**. Tooth possesses a central cavity that contains blood vessels, lymphatic and nerves along with some cells associated with the formation of dentine. These tissues occupy the central cavity called **dental pulp**. (Fig 5.8)

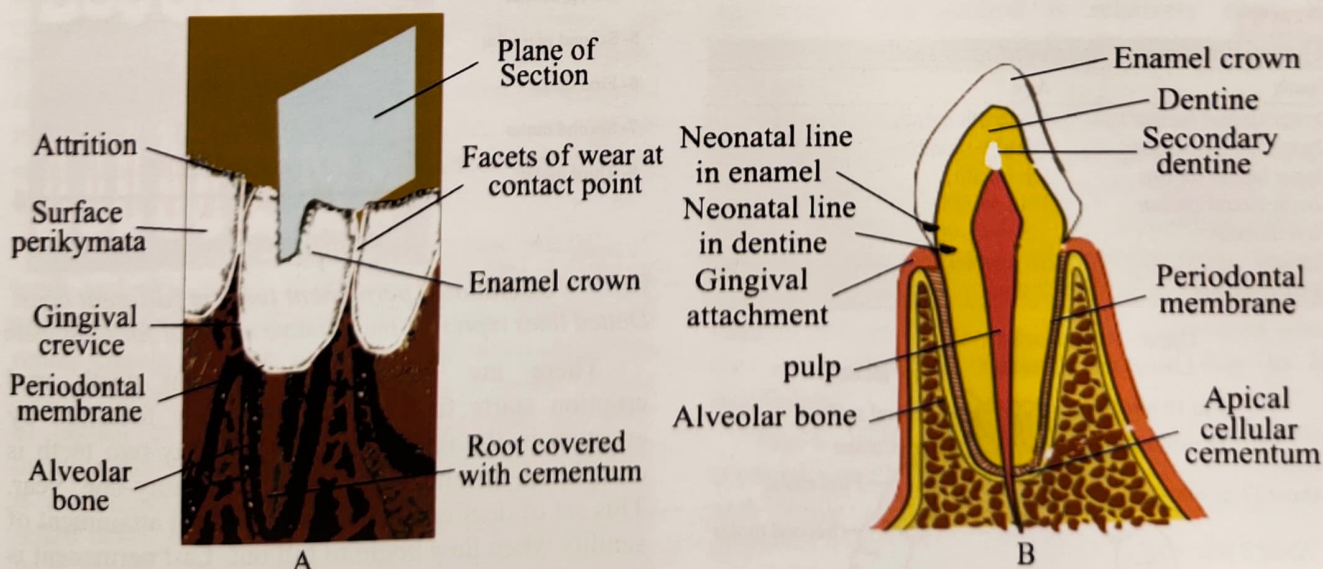


Fig 5.8: Tooth and supportive bony structures A. teeth in situ with plane of section B. longitudinal section

Growth process of teeth starts during pre-natal period and proceeds through post-natal period till attainment of 25th year of age. There are two types of dentitions, milk or **deciduous** and **permanent**. They develop one after the other first as soft cartilage and subsequently get calcified. Process of calcification is incremental having phases of activity and rest. Both enamel and dentine are formed by rhythmic alternate periods of formation and rest represented in the teeth as series of fine lines in a thin section, which can be seen under the microscope. Birth causes a marked transitory upset in this equilibrium, which is recorded as a well-marked line, called **neonatal line**.

Process of calcification of teeth starts at incisors at their tips of milk teeth, usually at fifth month of intrauterine period, continues at tips of remaining teeth from twentieth week onwards and further to the extent of two third in incisors and one third in canines and just tips in molars at the time of birth. Deciduous teeth remain in jaws for some years. Mixed dentition period ranges from the fall of the first deciduous tooth and eruption of the first permanent tooth starting generally at sixth or seventh year till fall of the last deciduous tooth, which is roughly in the twelfth and thirteenth year. Number with extent of eruption of deciduous and permanent teeth is guideline for estimation of age. (Fig 5.9)

There are ten deciduous teeth in each jaw. Their eruption begin in sixth or seventh month of age when the first tooth appears in the upper jaw and eruption of all deciduous teeth completed by end of two years. Calcification of the roots of these teeth is completed by end of third year. (Table 5.4 & Fig 5.10)

Table 5.4:

Age of Eruption of the deciduous teeth

Tooth	Age
Lower central incisor	6th to 8th month
Upper central incisor	7th to 9 month
Upper lateral incisor	9th month
Lower lateral incisor	10th month
First molars	12th month
Canines	18 months
Second molars	2 years

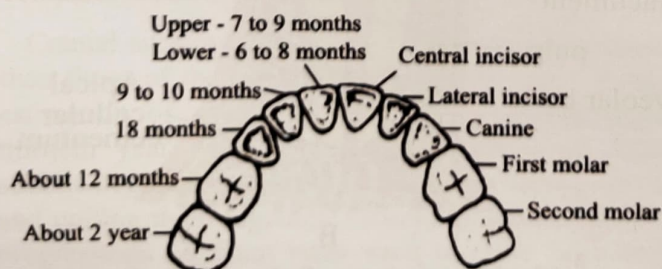


Fig 5.10: Eruption ages of deciduous teeth

Upper deciduous teeth:

A- Central incisor

B- Lateral incisor

C- Canine

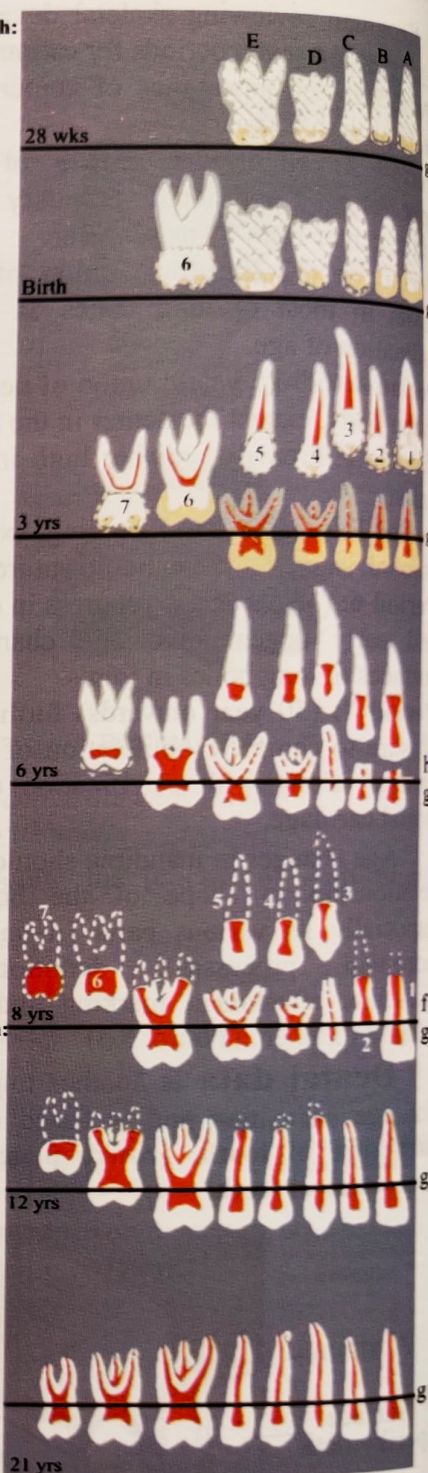
D- First molar

D- Second molar

E- Forming root

E- Gum level

E- Resorption of roots



Upper Permanent teeth:

1- Central incisor

2- Lateral incisor

3- Canine

4- First premolar

5- Second premolar

6- First molar

7- Second molar

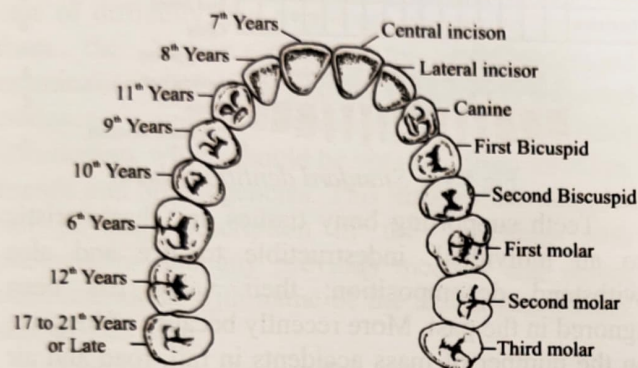
8- Third molar

Fig 5.9: Deciduous/ permanent teeth at different ages. Dotted lines represent the ultimate shape of forming teeth

There are thirty-two permanent teeth and eruption starts first in the lower jaw followed by eruption in the upper jaw. Set of thirty-two teeth is completed around eighteenth to twenty-one year. This set of dentition remains in jaws till attainment of senility when they begin to fall out. Last permanent is third molar; also called 'wisdom' tooth may not appear until 25 years. (Table 5.5 & Fig 5.11)

Table 5.5:*Age of eruption and completion of root calcification of permanent teeth*

Name	Year of eruption	Year of completion of root calcification
Central incisors	7	10
Lateral incisors	8	11
First bicuspid	9	12-13
Second bicuspid	10	13-14
Canines	11	13-15
First molars	6	9-10
Second molars	11-12	14-16
Third molars	17-18	18-21

**Fig. 5.11:** Eruption timing of permanent dentition

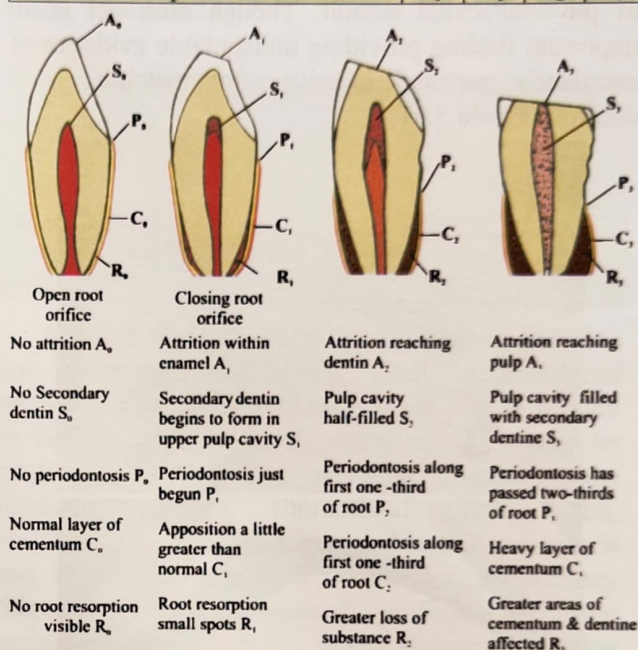
Once dental data is fully mature at about 25 years, age accuracy from them is only to the nearest decade and is based on general appearances in living cases. Further estimation of age from teeth over 25 years is not possible because of completion of processes of development and growth. Certain specialized tests of teeth may give an age in mature adult to within 5-7 years, but only on dead subject.

Wear-tear of teeth and its relationship with age assessment of adult over twenty-one years is complicated and entails consideration of physiological age changes in each of dental tissues, rate of which is not known. These changes are also influenced and obscured by onset pathological conditions. Further time of dentition can be altered with sex, diet and even with disease.

Gustafson (1950) studied wear-tear changes of teeth and this study is the first scientific work on aging of teeth. He observed that teeth damage and repair changes are of six types that were occurring due to constant use. He assigned them values as part of aging process. He is of the opinion that maintenance of shape of teeth after full development is a complex process and no single factor can be relied upon. He claimed that age of any tooth could be ascertained by his method with an accuracy of ± 3 years. (Table 5.6 & Fig 5.12)

Table 5.6:*Gustafson's criteria.*

Name of changes	Values			
Degrees of attrition	A ₀	A ₁	A ₂	A ₃
Alteration in level of gingival attachment	S ₀	S ₁	S ₂	S ₃
Amount of secondary dentine	P ₀	P ₁	P ₂	P ₃
Translucency of the root	T ₀	T ₁	T ₂	T ₃
Root resorption	R ₀	R ₁	R ₂	R ₃
Cementum deposit around root	C ₀	C ₁	C ₂	C ₃

**Fig 5.12:** Point's values allotted in determining age

Miles (1963) took his studies further on and stated that translucency of root alone is the most reliable of all of Gustafson's criteria for measurement of age. According to him, it can be noted with a microscope and method is relatively easy. He considers it quite accurate for determination of age with accuracy.

Boyd (1963) devised a method of age estimation from incremental features of enamel. Striations of the enamel prisms are daily increments of growth at the rate of four microns a day. The method consists of counting the number of cross-striations from the time of birth. The counting procedure is tedious and this method will probably only find its application when the most accurate estimate of age has to be determined.

Stack (1963) worked on teeth of infants and according to him, age of an infant is related to weight and height of developing teeth. Tables showing extent of development, calcification and eruption at a given age of a child and young person are available.

Beside age estimation from development of teeth, their arrangements can help determination of personal identification. It is based upon the theory that arrangement of teeth is individual's specific, visible during life and also remembered by others. Further, teeth bite imprints are also individual's specific when caused on human skin and food stuff. Such bite imprint can act as good means that can be relied upon for personal identity of aggressor in cases of physical/sexual assault. Though rare, yet is an important finding providing indisputable evidence of assailant's personal identity after matching with control. (Photo 5.4)



Photo 5.4: Bite teeth imprint on shirt and corresponding underlying skin of victim of left chest

Similarly teeth bite imprint on leftover food stuff like cheese or apple at scene of crime can act as good evidence of personal identification. Precaution is that examination and recording of description of teeth bite imprint on food stuff prepared at the earliest before distortion of bite mark along with its, photograph and cast models developed.

Dental fillings have definite shapes that can be recorded by X-ray and they are also individual specific. Dental surgeon can easily recognize own work. X-ray and photograph are good records of such dentine fillings, which can be referred to later. Furthermore, people pay regular visits to dental practitioners who keep accurate records of dental

treatment. Such dental records may help identification of an unknown person especially if the treatment given is in the form of dental fillings, dentures and even extractions. It is necessary to prepare record of findings on a standard dentition chart using specific notation symbols. (Fig 5.13)

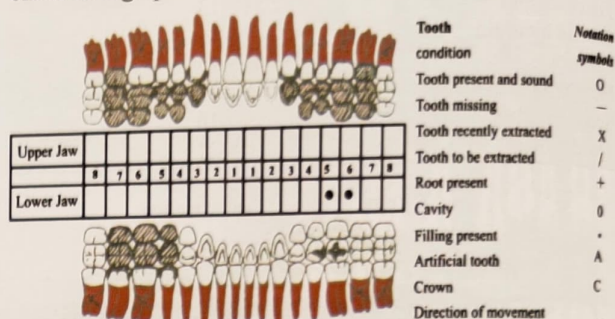


Fig 5.13: Standard dentition charts

Teeth supporting bony tissues are characteristic to an individual, indestructible to fire and also withstand decomposition; their value has been ignored in the past. More recently because of increase in the number of mass accidents in rail, road and air their importance have been enhanced. While investigating such accidents, medical examiner should follow a defined protocol to record observations in a way that others can read and understand. They should also use same symbols for charting.

Teeth forming parts of unidentified remains of mass road, railway or air disaster involving many victims should be carefully collected from accident scene and taken to laboratory for their detailer examination. Objective of such an examination is to know the number of individuals along with determination of their identity parameter such as age, sex, race or any other feature of special interest. Protocol of examination consists of two stages:

- **Initial examination at the locus**
- **Subsequent in the laboratory**

Initial examination at the locus is undertaken in two steps; area charting and collecting of evidence. Area charting starts by its sealing from public interference for smooth search and to avoid contamination. Whole area bearing human remains is divided into plots of reasonable size and each portion numbered. Collecting of evidence is careful search of displaced parts especially teeth, fillings, crowns and dentures. Great care should be exercised in the handling of remains subjected to heat or fire to avoid damage to them. Human remains having teeth should be removed from the scene in special containers.

which are numbered according to the number of portion of the plot. Each container should bear a tag showing number of plot and site of recovery. It should be done after preparing area diagrams or taking area photograph, Advantage must be taken of photography at every stage.

Subsequent in the laboratory examination includes physical examination of each recovery, taking radiograph of the whole dentition/ skull or their supporting parts to know about dental cavities, fillings or any other treatment provided previously. In case of difficulty, the fragments should be removed from the human remain for more detailed examination. It is followed by co-relating collected evidence with individuals' characteristics information, which should be obtained from relatives, friends and other agencies. This information includes full physical description of the individual with photographs and any previous medical and dental treatment along with name of the dental practitioner who treated him.

Determination of sex till recently was quite simple, but biological research has confirmed that none of the existing criteria for determination of sex are reliable. Categories 'male' and 'female' are not mutually exclusive. Medicine has invented a new term *intersex* to cater for new situation for both *intermediate* and *indeterminate* situations. Current trend to establish precise diagnosis about sex of an individual consists of three investigations:

- **Anatomical**
- **Chromosomal**
- **Psychological**

Anatomical comprises of noting of external body appearance of an individual both natural and acquired, more particularly shape of the body such as convexity at nipples, concavity upward of pubic hair, hair style and dress. Additionally, one may perform a genital test by observing presence of penis or vagina and may confirm by gonadal test the presence of ovary or testis by radiographic exploration and even microscopy of ovarian or testicular tissue.

Determination of sex in cases of mutilated or decomposed bodies depends mainly upon anatomical investigation other than external appearances. Hair, non-gravid uterus and prostate gland resist putrefaction and these structures may help in some cases. Main parameter, which is still left and is useful for anatomical investigation in such cases, is bones. Limitation of this parameter is that age and sex go

together till puberty and recognizable sex differences do not appear up to the age of majority. Unto this age, female bones are comparatively smaller and lighter in weight. After this age, sex can easily be established with considerable accuracy from morphological characteristics of the bones. Both subjective and objective methods should be undertaken for examination of the bones. Bones have a high percentage of accuracy for the determination of sex. (Table 5.7)

Table 5.7:

Percentage accuracy of bones for sex determination

Entire skeleton	100%
Pelvis	95%
Skull	92%
Pelvis and skull	98%
Pelvis and long bones	98%
Long bones	70 - 80%

Skull in females is smaller, lighter and has 10% less capacity than male skull. Cranio-facial proportions are similar in both sexes. Facial portion in the female is relatively smoother. This may be confirmed by observing mandible, contour of the forehead, glabella, supraorbital ridges, orbit, cheekbones and nasal aperture. Mastoid process is less prominent in females than males. Superciliary ridges are less pronounced in females. Fusion between nasal and frontal bones shows a smoother curve from the forehead to the base of nose in females whereas in males there is a distinct angulation besides more prominent and rough zygoma. Orbital opening is rounded and smaller in the female where as in male it is squarish and larger. (Table 5.8)

Sternum & manubrium and their relative size differ in both sexes. Body of sternum is more than twice the length of manubrium in males and average index in males is 46.2 and in females 54.3. (Fig 5.14)

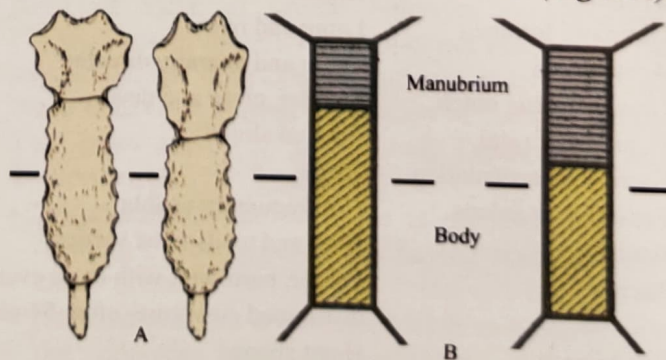


Fig 5.14: Relative size of manubrium and body of the sternum

Table 5.8:
Morphological sex difference in skull

Feature	Male	Female
Whole skull	Large (Endocranial volume is about 200 cc. more in male)	Small
Architectural design	Rugged	Smooth
Orbit	Squarish, relatively smaller, lower and with rounded margins	Larger, higher and with sharp margins
Supraorbital ridge	Medium to large	Small to medium
Cheek bone	Large and more laterally prominent	Small and more flat
Parietal protuberance	Small	Large
Forehead	Steeper and less rounded	Rounded and full
Frontal prominence	Small	Large
Mastoid process	Medium to large	Small to medium
Occipital region	Muscle attachments and protuberances prominent	Muscle attachments and protuberances less prominent
Occipital condyles	Large	Small
Mandible	Large, with higher symphysis and broad ramus	Small, with less corpal and ramal dimensions
Palate	Large, broader and U-shaped	Small, narrow and parabolic
Teeth	Large, with first lower molar having 5 cusps	Small, with all molars having 4 cusps

Pelvis as a whole inclusive sacrum in females is light, less massive, and smoother and likes a flat bowl. In males, it is heavier, massive, rugged, with marked muscular sites and deep like a funnel. Subpubic angle in females is of 90° and in males 65° to 70° . The greater sciatic notch in females is wide and in males is narrow. Sciatic angle in females is 90° and in males 70° . Sciatic notch index is the most useful criterion. Acetabulum in females is narrow and in males, it is wide. Sacrum in females is short, wide, light and almost straight in its upper half and curved only in the lower half whereas in males it is longer less wide, heavy and has a uniform curve. The

articular surface in females extends upto 2nd and in males upto 3rd vertebra. (Fig 5.15 & Table 5.11)


Fig 5.15: Morphological sex differences of pelvis and sacrum A. female and B. Male

Table 5.9:
Morphological sex differences in pelvis

Feature	Male	Female
Whole pelvis	Massive, rugged, marked muscular attachments	Less massive and smoother
Subpubic angle	Acute and V-shaped	Rounded, broader, U-shaped
Symphysis	Higher	Lower
Obturator foramen	Large and ovoid	Small and triangular
Acetabulum	Large and laterally directed	Small and anterolaterally directed
Greater sciatic notch	Smaller, close and deep	Larger, wider and shallower
Ischiopubic rami	Everted slightly	Everted strongly
Sacro-iliac articulation	Large	Small
Preauricular sulcus	Not frequently visible	More frequently developed
Ileum	High and tends to be vertical	Lower and divergent laterally
Sacrum	Larger, narrower, with more evenly distributed curvature; often 5+ segments	Smaller, broader, with tendency to marked curvature in the upper and lower segments
Pelvic brim	Heart shaped	Circular or elliptical
Pelvic cavity	Relatively smaller	Oblique, shallow and roomier

Chromosomal depends upon a technique, in which nuclear material of cell could be disentangled and render the constituent parts of nucleus visible under the microscope. It has been revealed that in humans, there are 46 chromosomes in 23 pairs. Each pair differs both in size and shape. One component of each pair is derived from each parent. Furthermore there is difference in men and women in one of the 23 pairs as other 22 pairs are indistinguishable between sexes. In females, there is a pair, which consists of two medium sized chromosomes known as X chromosomes, and in males, one of these X chromosomes is missing and is replaced by Y chromosome. Females, therefore have 2X (XX) while males have one X and one Y (XY).

It was thought that difficulties of determining sex could be resolved by easy process of identifying sex chromatin, but nature is not as simple as this. There are many stages of development of XX embryo into a normal female, and XY embryo into a normal male. Process is complex and on many occasions ends up far from the expected normal, resulting in the formation of different combinations. Except the first two, all are classed as intersex. (Fig 5.16 & Table 5.10)

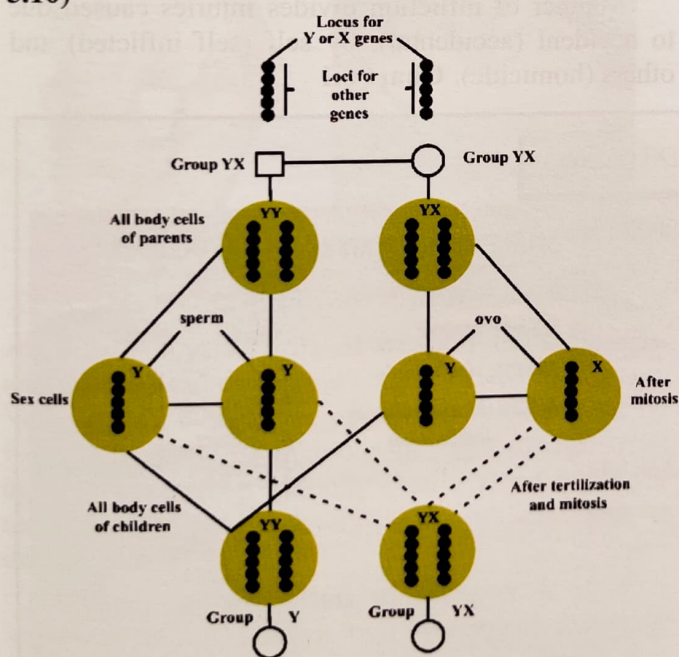


Fig 5.16: A. Diagrammatic representation of a pair of chromosomes. B. Inheritance of blood group system XY showing the segregation of the sperm and ova.

Sex chromatin material recognition in male/female cells is done by locating **Davidson body**, a drumstick shaped condensation in some percentage female white blood cells and **Barr body**

situated just close to nuclear membrane in epithelial cells of females especially buccal mucosa. Both stain more deeply than the rest of nuclear material. (Fig 5.17)

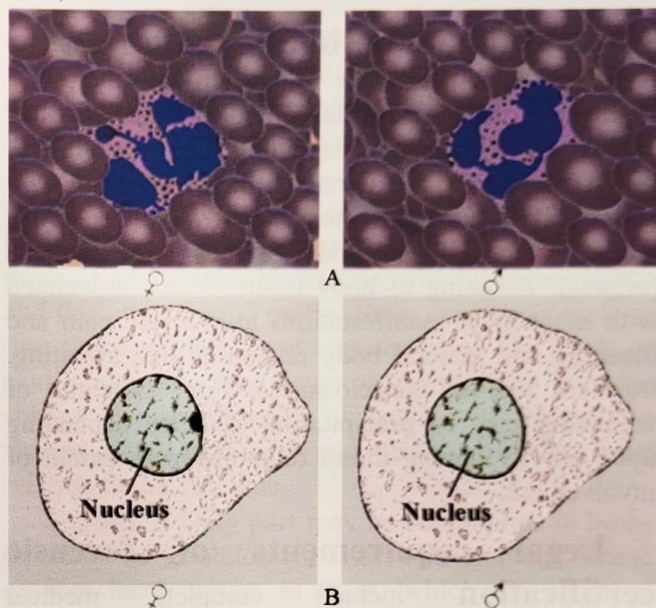


Fig 5.17: Slides showing difference due to sex chromatin. A. Davidson body in female white blood cell. B. Barr body in female buccal epithelial cell.

Table 5.10:

Different combinations to sex chromosomes		
XX	-	Normal female
XY	-	Normal male
XXY	-	Klinefelter's Syndrome (Feminized infertile male)
XXXY	-	Variant Klinefelter's Syndrome (Mosaicism)
XXX	-	Super Female or Triple-X Syndrome
XO	-	Turner Syndrome
XX-XY	-	True hermaphrodite

Psychological assessment, especially from the point of view of sexual behavior is important. Physical sex of an individual may not conform to the psychological development of an individual and those behave abnormal are placed in intersex group. Two types are so far recognized; **Transvestite** and **Transsexual**

- **Transvestite** is the one who is obsessed with the clothing of the opposite sex having compulsion to cross-dress.
- **Transsexual** has a dominant wish to identify with the opposite sex as completely as possible discarding forever his or her own anatomical sex.

CHAPTER 6

6. Forensic Aspect of Wounding (part 1)

Wounding of body tissue due to accident, by self or other and when by other, is a cognizable offence punishable under related sections of Pakistan Penal Code depending upon its gravity. When breaking is external, it involves skin with underlying tissues and when internal involves serous lining (membrane) of body cavities with contents (organs). Breaking of body tissue is also associated with other local manifestations at site like pain and bleeding and general body responses like sweating, transient loss of consciousness. Final outcome of wounding may be precipitation of death depending upon gravity having direct relationship to extent of involvement.

Legal requirements of forensic certification include complete medical observations starting with shape, size, character of margins, description of local at site and generalized responses to whole body including vital system as manifested in the form of signs and symptoms suffered by the victim should be made part of certification protocol. Estimation of age of

wounding/duration of injury and manner of its infliction are essential inferences. It is emphasized that only those medical practitioners having knowledge and understanding of interaction between weapon of offence causing wounding and body part including various tissues should do this task. Medical practitioner is further advised not to embark upon this task, unless he is formally authorized to do it. Further, such task should be undertaken only at purpose designed/built **medico-legal clinic**, equipped with necessary logistics and supported with a trained paramedic.

Type of wounding conventionally has been classified either on the basis of weapon used or manner of its infliction. Typing due to weapon used includes single causative factor injury by blunt and sharp edged weapon and other is fire arm injury due to multiple causative factors weapon like smooth/rifled barrel weapons and bomb blast.

Manner of infliction divides injuries caused due to accident (accidental), by self (self inflicted) and others (homicide). **Chart 6.1**

WOUNDING IMPLEMENT (Weapon)			
HAVING SINGLE CAUSATIVE FACTOR	HAVING MULTIPLE CAUSATIVE FACTOR	MANNER OF APPLICATION	RESULTANT INJURIES
<p>Mechanical</p> <ul style="list-style-type: none"> Blunt Sharp cutting edge Sharp pointed edge <p>Other</p> <ul style="list-style-type: none"> Temperature <ul style="list-style-type: none"> Heat <ul style="list-style-type: none"> Flame Hot liquid Cold Electricity <ul style="list-style-type: none"> Low voltage <ul style="list-style-type: none"> Loose contact High voltage <ul style="list-style-type: none"> Firm contact Radiation <ul style="list-style-type: none"> Artificial <ul style="list-style-type: none"> Ionizing Natural <ul style="list-style-type: none"> Non-ionizing Corrosive <ul style="list-style-type: none"> Acid Alkalie 	<p>Bomb blast</p> <p>Fire-arm</p> <ul style="list-style-type: none"> Shot gun Rifled weapon <ul style="list-style-type: none"> Low velocity bullet High velocity bullet 	<p>Self-injuring/suicide</p> <p>Assaulting other/homicide</p> <p>Accident (domestic, industrial, transportation)</p>	<p>External</p> <ul style="list-style-type: none"> Closed <ul style="list-style-type: none"> Abrasion Bruise Burn Open <ul style="list-style-type: none"> Incised Lacerated Fire-arm <p>Internal</p> <ul style="list-style-type: none"> Intra-cranial Intra-thoracic Intra-abdominal

Chart 6.1: Classification of wounding implements (weapon), manner of application and resultant injuries

Wounding when caused mechanically is called **mechanical injuries**. They are the most commonly encountered form of wounding. Medico-legal certificate of such an injury should only be factual statement directed towards its type, site, appearance, gravity, duration of infliction and weapon causing it.

Factor controlling shape of injury is either weapon or part struck each having its ingredients. (Table 6.1)

Table 6.1:

Factor controlling shape of wounding

Weapon	Part struck
Type	Architecture of body part
Weight and velocity	Movement of the part
Manner of execution	Tissue resistance

A. Factors in weapon:

Type of weapon directly controls and determines the appearance of the wound. Examples are incised and lacerated wounds produced by sharp edged and blunt edged weapons. (Photo 6.1)

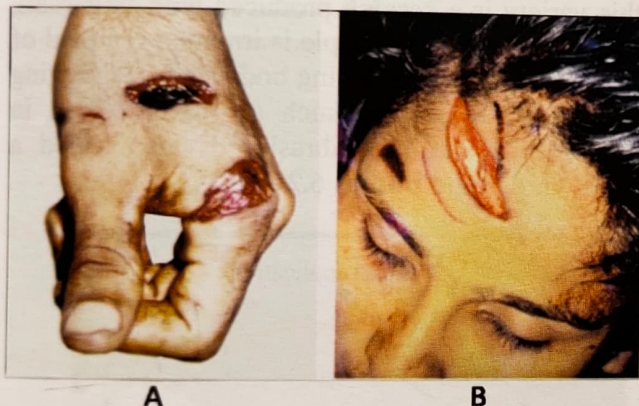


Photo 6.1: A. Incised and B. lacerated wound

Weight and velocity of weapon and their sum-total control and determine appearance of the wound. Velocity has kinetic energy, which is calculated by formula, $K.E. = 1/2mv^2$. A bullet in flight though small in mass has greater velocity than a stone bigger in mass having less velocity shall produce greater damage and effect.

Manner of execution of weapon is another important factor. There are two manners of execution of weapon or infliction of weapon; **direct** and **indirect**.

Direct application produces wounding at the point of the contact like produced with stone or club on the head.

Indirect application causes injury at a place away from site of contact. Fracture of clavicle produced by fall on stretched hand is its example.

B. Factors in part struck:

Architecture of part struck with its behavior following a strike has specific relationship to the outcome.

Human body is composed of different types of tissues. They are *soft* and *elastic* like skin, fat, muscle and internal organ, relatively *rigid* and *less elastic* like ligament and cartilage and *hard* and *limited elastic* like bones. Bone elasticity depends upon person's age, extent of calcification and **shape of the bone**: Bones of infants are relatively elastic than those of adults and old persons, which become brittle and thus, break more easily. Bone shape may be long like those of limbs and ribs, or plate like vault of skull and crest of the ileum or short having irregular shapes like small bones of hands and feet. These shapes along with size and density of bone have relation to the outcome.

Further, a body part may be *compact* as in limbs or *cavity* as in abdomen, chest and cranium. These cavities have organs in them, which are again of different shapes and consistency being composed of different types of tissue. Because of the design of these organs, they have different behavior character:

- Liver, spleen and kidney are solid
- Lungs are spongy and contain air in them
- Stomach, intestine, heart, gall and urinary bladder are hollow sacs having fluid or semi-solids of different density in them like blood in the heart, bile in gall bladder, water mixed food in stomach and intestine and urine in the urinary bladder.

Strike with a club, a blunt weapon, having same force on different body parts having different architecture will produce different shaped injuries i.e. on the head it shall produce a laceration, whereas similar impact on the buttocks shall produce a bruise. This difference in the shape of wound is due to the difference in architecture of the body part. Head has scalp stretched over a bone whereas buttock comprises mostly of soft tissues of skin, fat and muscles. Hip bones within are deeply buried.

Movement of the part also affects the outcome. Difference can be appreciated by noting injuries produced when the part is stationary or in motion. It is best manifested when a body cavity like head or chest is involved. A strike to a stationary head will produce a local injury of the scalp at the site of contact and damage may extend even to deeper structures. On the other hand, if moving head strikes a stationary object, the resultant trauma to the head

will be combination of local injury externally at site of deceleration and additionally a deceleration effect to the internal contents of the cranium at two sites involving both the membranes and the brain substance. These injuries to membranes and brain are due to pressure strains caused by concentration and rarefaction produced because of movement of the membranes and brain matter. The injury immediately below the site is called **coup-injury** and another at a point diagonally opposite to the point of contact **contre-coup injury**. (Fig 6.1)

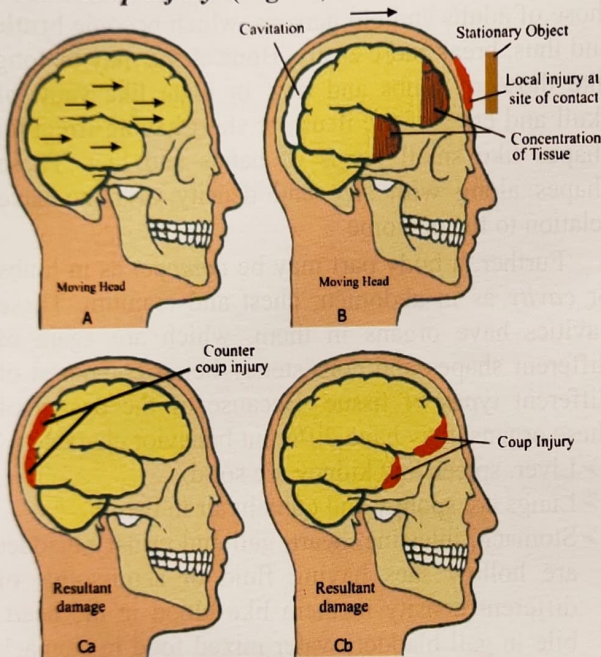


Fig 6.1: Moving head halted by a stationary object **A**. Head in motion **B**. Local scalp injury at the site of halt, cavitation and concentration of brain tissue **Ca** and **Cb** resultant brain tissue coup and contre-coup injuries

Tissue resistance can absorb force without suffering damage depending upon tissue type, extent of surface area and also tissue is soft and elastic. Skin and muscle absorb force more effectively causing either no damage or only a bruise. Hard and inelastic tissue like skull having soft scalp over it will not absorb impact and instead will cause scalp laceration and fracture of the bone. (Fig 6.2)

Relationship of shape of injury with mechanism involved of most commonly encountered injuries during forensic certification will individually be discussed one by one:

Abrasion is an extremely trivial damage restricted to the most exterior part of the skin. Its causation is important. When a hard and rough object

with pressure is moved against body surface, an abrasion will be produced. There are three types:

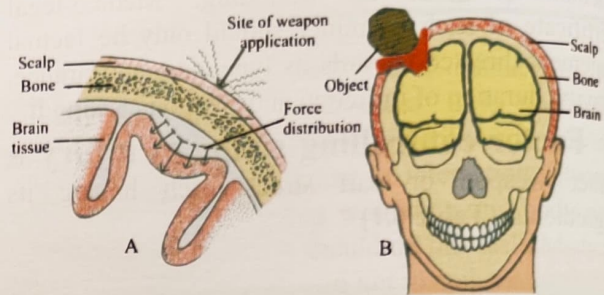


Fig 6.2: Tissue resistance mechanism with hard inelastic skull bone and soft scalp over it **A**. Force application with distribution of force **B**. Scalp laceration with skull fracture

- **Moving abrasion**
- **Imprint abrasion**
- **Friction abrasion**

Moving abrasion indicates direction of abrasive force, showing heaping or piling up of the epidermis on the far end. Appearance is characteristic. Example of this variety is a **scratch** produced with fingernail, pin or thorn. Another example is irregular removal of the epidermis occurring during body surface dragging against the rough object such as road as seen in vehicular accident. This abrasion is also called a **graze**. (Fig. 6.3 and photos 6.2 & 6.3)

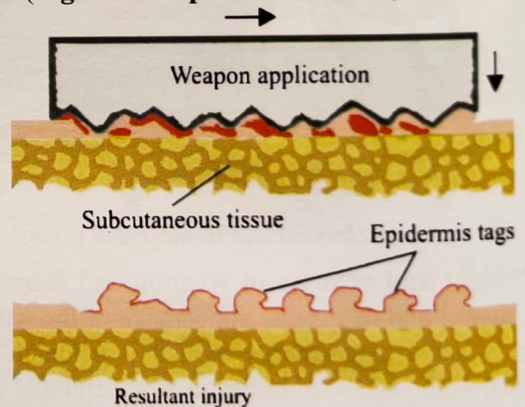


Fig 6.3: Mechanism of moving abrasion

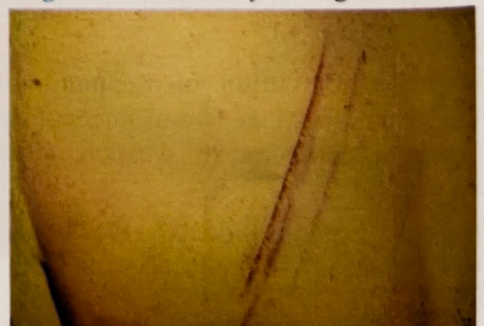


Photo 6.2: Scratch on back of chest



Photo 6.3: *Graze on arm and elbow*

Imprint abrasion is caused by strike of hard and rough object on skin like shoe-heel and *friction abrasion* by hard ligature material around neck. Its pattern provides corroborative evidence of causative agent. Imprint abrasion produced by hard ligature material such as rope around the neck in hanging shows both indentation and frictional rub. Pattern of ligature material provides corroborative evidence of causative agent. (**Photo 6.4 & 6.5**)



Photo 6.4: *Ligature around neck in position*



Photo 6.5: *Frictional rub and indentation of neck skin without ligature*

It is important to stress and remember that postmortem removal of epidermis by rough handling of corpse or rubbing against hard object occurs during postmortem period. Postmortem abrasion may be confused with ante-mortem abrasion especially when on vital region like neck. Post-mortem abrasion looks fainter and with passage of time after drying acquires parchment appearance. Ante-mortem abrasion shows vital reaction. Example is a case of newly wedded women wearing heavy silver necklace died from massive hemorrhage during consummation of marriage. She, besides vaginal damage also had three post-mortem abrasions; two in front of the neck and third blow left chin caused by heavy silver necklace. Police during initial inquiry labeled her death due to throttling (**photo 6.6**)



Photo 6.6: *Postmortem abrasions on the neck and chin*

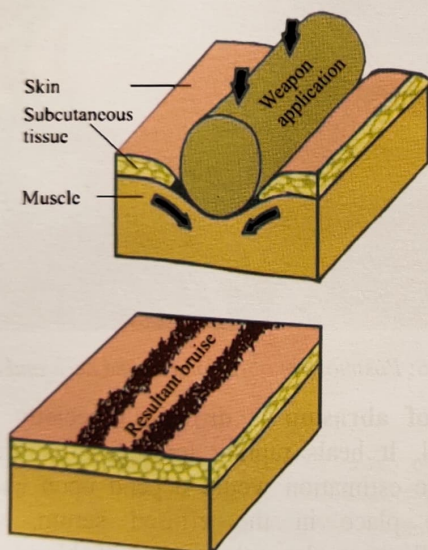
Age of abrasion is difficult especially when superficial. It heals rapidly leaving no permanent mark. Age estimation would depend upon changes that take place in the effused serum, which occasionally may also get mixed with blood. Fluid when dry varies in color from straw to yellow to brown, depending upon the amount of blood. It is followed by formation of a soft scab in about two days, which hardens in about another three to four days. Hard scab retracts in another three or four days and finally falls away. Time relation of these changes through variable, yet is only an indicator for duration.

Bruise also called **contusion** is a closed wound caused by strike of a blunt weapon. It results from sudden tissue indentation followed by recoil. Area struck becomes swollen, red and painful without solution of continuity of covering skin. Though skin is not dissolved, yet its structure, adjacent subcutaneous tissue and other structures beneath it, depending upon its depth gets damaged. A bruise generally acquires the shape of striking weapon.

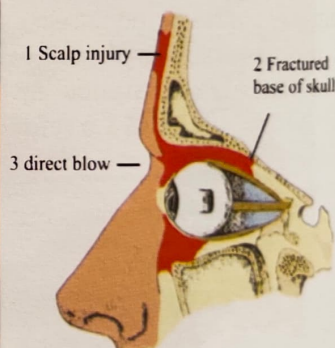
Extravasations of the blood from the broken blood vessels spread into the surrounding tissue. It is more commonly met with on body surface, but bruising of internal organs like liver and kidney also occurs. Appearance and severity of a bruise depends upon certain factors (Table 6.2, Fig 6.4, Photos 6.7 & 6.8)

Table 6.2:**Factors controlling appearance and severity of bruise**

1. Age (children/old people bruise easily)
2. Amount of force applied
3. Quantity of effused blood
4. Type of tissue (blood spreads easily in lax area around eye and lips)
5. State of health (coagulation defect, disease of blood vessel and liver cause more bleeding giving false impression about severity)
6. Skin color (visibility better in fair people)

**Fig 6.4: Mechanism of Bruise****Photo 6.7: Two bruise marks on lateral side of right thigh****Kidney****Liver****Photo 6.8: Bruise mark on kidney and liver**

Gravity shifting of bruise occurs from its initial site along tissue line of least resistance to lower region under the influence of gravity within first 24 hours. It changes both its position and shape as noticed following a blow on the forehead/scalp and later causing *black eye*. It is advisable and valuable to re-examine victim after about twenty-four hours of the first inspection. Route and known cause of black eye are also indicated in the drawing. (Photo 6.9 & Fig 6.5)

**Photo 6.9 & Fig. 6.5: Black eye resultant from gravity shifting of blood of injury to forehead**

Age of bruise is estimated by noting changes in the color of effused blood, which occur with the passage of time. Color changes depend upon ability of the tissue to absorb it. Capillary blood is dark red in color and a recent bruise appears purple in color. It darkens in two days because oxygen in the blood is removed. Tissue enzymes begin to change hemoglobin into blood pigments and in about four/five days, the bruise becomes greenish. Fading of the bruise occurs because of absorption of pigment. Further, within seven to ten days, color changes to yellow and finally disappears in about fifteen days depending upon site, size and depth of the extravasations.

It is necessary and also important to stress that repeated strikes to body part at same point as is done by police during investigation is called **battering**. It breaks body tissues, interferes with process of oxygenation/enzyme action and accelerates blood color change from first two days to few hours causing rapid darkening of effused blood to deep blue in color. It should not be confused with normal color change reaction occurring with passage of time. (Photo 6.10)



Photo 6.10: Police battering bruises on buttocks showing deep blue color

Pseudo-bruising may appear in skin, internal organs and other tissue spaces by accommodation of intense localized postmortem lividity. It is due to displacement of internal pools of blood by gas pressure into areas away from actual hypostasis. It simulates ante-mortem bruising and should be differentiated. Differentiation becomes difficult in cases of congestion without inflammation. Area showing pseudo-bruising lacks vital reaction. Importance in distinction lies in the fact that bruising is an ante-mortem phenomenon indicating violence before death. (Table 6.3)

Table 6.3:

Salient features differentiating hypostasis from bruise

Hypostasis

1. Lacks vital reaction.
2. Blood accumulates within the vessels and when incised, oozes out of the cut mouths of the blood vessel
3. Confined to skin and covering of the internal organ like mucosa or serosa
4. Cuticle of the skin is intact as it is only an accumulation of blood due to gravity
5. Always appears in a dependant part
6. Sustained pressure however prevents appearance of hypostasis

Lacerated wound is an open wound showing breach of skin or covering of an internal organ along with underlying tissues caused by strike of blunt weapon. Main characteristics of a lacerated wound are varied shapes with irregular margins, ill defined angles and walls that have bridging tissue tags and hair in bearing area may get pushed into it with hair bulbs crushed. This area finally gets denuded of hair. External hemorrhage is limited. (Photo 6.11)



Photo 6.11: Lacerated wound on scalp showing characteristics of irregular margins, ill defined angles and bridging tissue tags

Depending upon mechanism of its causation, there are of three types:

- **Split**, also called **crush laceration**
- **Over-stretch laceration**
- **Grinding compression laceration**

Split laceration occurs on scalp, forehead, chin or any other part of the body where skin is firmly supported by underlying bone. Sudden compression of the skin and other tissues between the weapon and the underlying bone split them. It may resemble an incision wound.

Bruise

1. Shows vital reaction (swelling and inflammation)
2. Blood vessels are broken and blood is present in blood surrounding inter-statis tissue. No flow of blood occurs upon cutting of vessel
3. Lies in the inter-statis tissue below epidermis or even deeper to it, as epidermis is without blood vessels
4. Cuticle is damaged and may show abrasions due to the of violence causing it
5. Occurs at the site of injury, irrespective of its being dependant.
6. It occurs independent of pressure

Characteristics of recognition of such a wound are breach of skin and underlying tissue showing minimal irregularity and bruising of the edges and surrounding tissue. Hair if present at site of tearing are forced into the wound and bulbs of hair are crushed. Denudation of hair in hair bearing area may occur. (Fig. 6.6 & Photo 6.12)

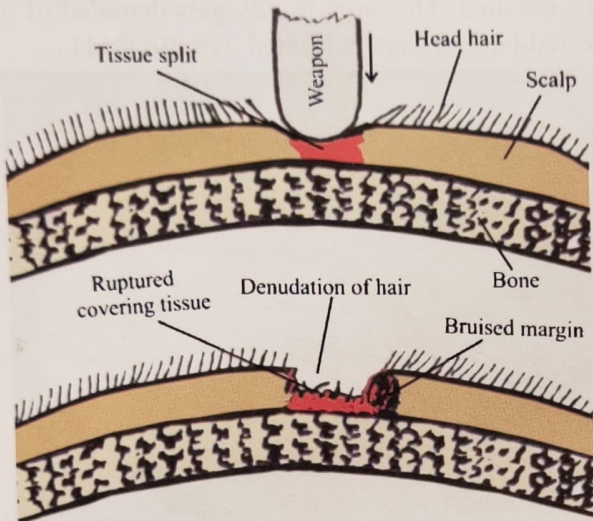


Fig.6.6: Mechanism and resultant split laceration



Photo 6.12: Split laceration resembling incised wound on left cheek

Over-stretch laceration is commonly seen in areas of the body where skin is loosely supported such as back of hand, upper part of the foot, forearm, and axilla. When localized pressure along with push or pull of increasing intensity overstretches the skin, it ruptures and gets separated from the underlying structures. Such laceration generally occurs in road traffic accident and industry. Part of the body while being trapped sustains such an injury. Rupture of the skin due to over-stretching may also occurs due to fracture and deformity of a bone. Characteristics of

such laceration are breach of skin and separation from the underlying tissue showing flapping in the direction of stretch. External hemorrhage in the tears is limited (Fig 6.7 & Photo 6.13)

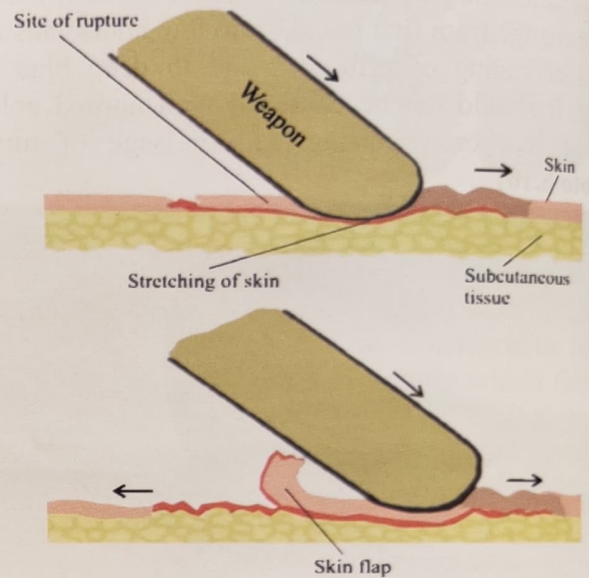


Fig 6.7: Mechanism and resultant split laceration



Photo 6.13: Over-stretch laceration, showing skin flap

Grinding compression laceration is caused by passing of heavy automobile wheel over limbs of the body and producing grinding compression of muscles. Characteristics of such a wound are multiple skin perforations that are also separated from the underlying structures, crushing of muscles and other supportive tissue. There is extreme extravasations of blood into potential spaces of crushed tissue, which shows swelling and is severely painful. External bleeding from these wounds is generally limited. When such laceration occurs over wide area, they may precipitate fat embolism or crush syndrome. Clinical state would depend upon the number of wounds, extent and speed of hemorrhage, finally causing death from renal failure. (Fig. 6.8)

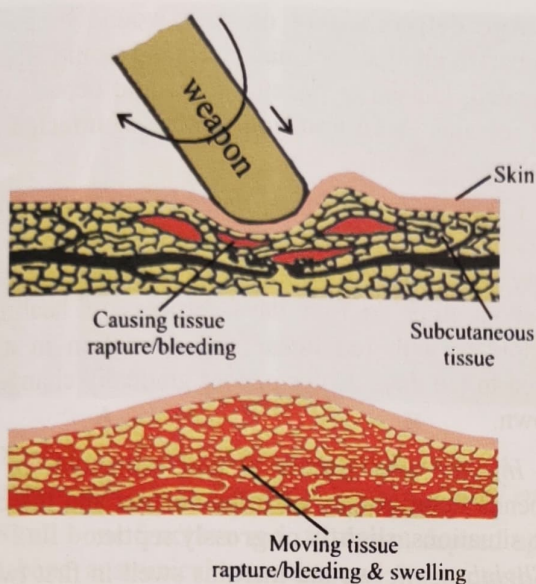


Fig 6.8: Mechanism and resultant grinding compression

Incised wound is another open wound resulting from cutting or incision of skin and underlying tissues. The most common instrument causing it is a knife or a sharp edged cutting glass. Movement of the weapon is necessary ingredient for causing a cut in the tissue. Characteristics of such a wound depend upon shape of weapon and manner of its infliction, which affect both its shape and dimension. An important feature of this wound is involvement of covering clothes consistent with site of infliction, which also gets stained with blood. Wound is generally linear or spindle shaped, gaping in the center depending on cleavage lines of Langer. It shows clean cut margins, sharp angles and smooth walls. If involved area is hair bearing, it shows cutting of hair including bulbs. External hemorrhage from incised wound is comparatively more than from a lacerated wound and contrasting features enlisted. (Table 6.4, Fig 6.9 & Photo 6.14)

Table 6.4:

Contrasting features of incised and lacerated wounds

Features	Incised wound	lacerated wound
Shape	Linear or spindle	Irregular
Margins	Regular	Irregular
Angles	Sharp, well defined	Blurred, ill-defined
Walls	Smooth, having no bridging or tissue tags	Irregular, showing tissue tags
Bleeding	Profuse	Comparatively less
Hair	Cut in its line	Pushed into it
Hair bulbs	Cut in its line	Crushed
Area around	Shows no bruising	May be bruised or denuded of hair
Clothes	Correspondingly cut	No such effect

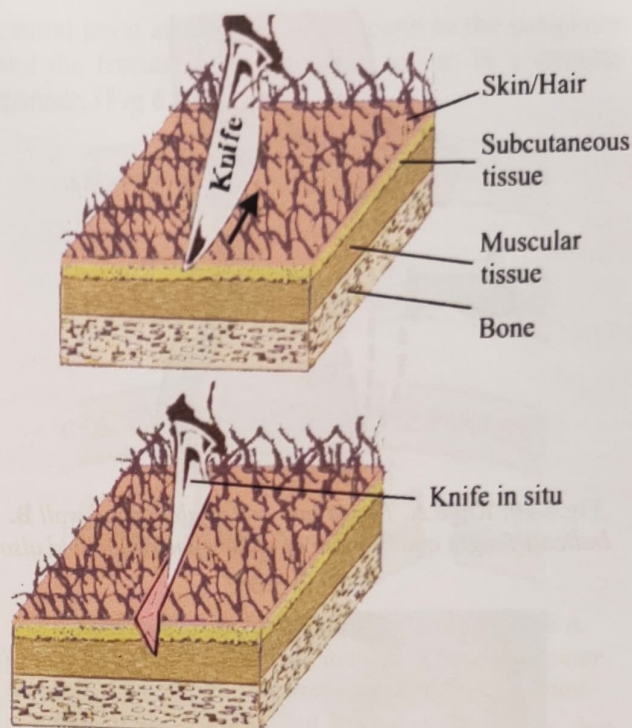


Fig.6.9: Mechanism and resultant incised wound



Photo 6.14: Incised wound on face showing spindle shape, sharp angles and clean cut margins

Penetrating & puncturing wound is produced by thrusting sharp edged and pointed weapon into part of the body having a cavity like cranium, chest and abdomen which gets pierced. Shape, external dimensions of length and breadth and internal depth of wound depend upon shape and size of cutting blade of the weapon causing it. Most of the characteristics of this wound are similar to those of an incised wound, except the depth, which is the greatest dimension. (Fig. 6.10 & Photo 6.15)

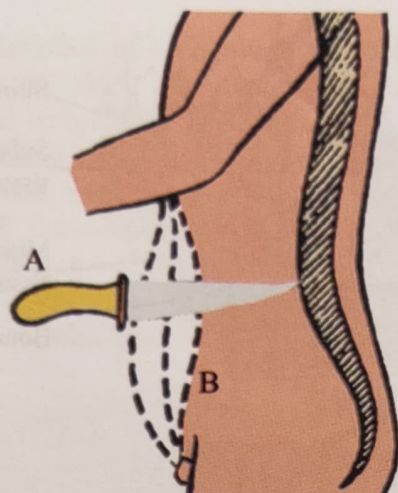


Fig.6.10: Knife A. Thrust into dolled abdominal wall B. Indicate length and breadth of blade penetration and also depth of injury



Photo 6.15: Penetrating wounds chest with weapon in situ



Photo 6.15: Penetrating wound abdomen with bulging out intestines

Description of external wound of such victims is usual routine, but clinical condition is serious manifesting signs of acute hemorrhagic shock due to extensive hemorrhage. In penetration of chest cavity, additional feature is development of hemo-pneumothorax and surgical emphysema in the surrounding area.

Age determination of open wound because it comparatively does not stay clean and would whether lacerated, incised or penetrating would depend upon if it remains **clean and non-gaping** or **infected and gaping**.

Clean and non-gaping wound gets covered over by lymph and blood, which clot in first twenty four to thirty six hours. It is followed by adherence of edges in about three to four days. Process of healing is completed with red linear scar formation in about seven to ten days. Color of scar gradually changes to brown.

Infected and gaping wound estimation of age depends upon gravity of inflammation and there are two situations; **slightly** or **grossly septic**:

- *Slightly septic* wound margins swell in first twelve to sixteen hours, followed by appearance of sero-purulent discharge in about three to four days. It is followed by formation of red-granulation tissue in the bed of the wound in about five to six days, skin grows over it and healing gets completed in twelve to sixteen days. Fresh scar in such a wound is more prominent and slightly raised over the surface of the skin
- *Grossly septic* wound remains open indefinitely and no estimation of age is possible

Bone fracture takes place either by direct mechanical application of force or impact or indirect application of force. Long and skull bones are mainly affected depending upon amount of force weather **slight** or **greater**:

- *Slight force* within the limit of bone elasticity will cause a local indentation at site of impact without breaking bone and then recoil back to its original shape like any soft body tissue
- *Greater force* beyond the limit of bone elasticity will produce fracture, which commences at the point of maximum convexity

Long bone fracture of adult occurs either at the point of impact or bone acting as a lever diverts the force to other remote weaker point, which gets fractured. Long bones of children are comparatively more elastic and show less damage to only one side of bone close to application of force resulting in **green stick fracture**. Examples of indirect application of force are spiral fracture by limb twisting and transverse fracture or separation of epiphysis by limb push/pull as generally seen in battered baby syndrome. (**Photo.6.16**)

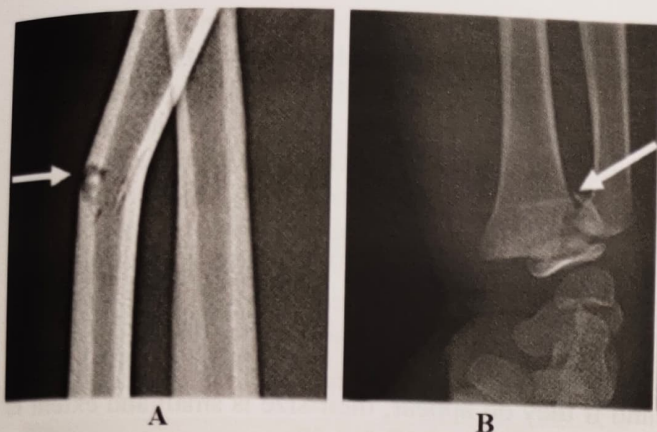


Photo.6.16: X-ray image of radius of children **A.** Greenstick fracture **B.** Transverse fracture of distal end

Skull bone fracture and its pattern depend upon skull bone anatomical structure and its strength. It varies at different parts due to thinness's and thickening's in both vault and base. When direct force is applied, a linear fracture radiating from the point of impact occurs and in case of indirect application of force, fissured fracture distant from site of impact occurs. Occasionally force from the face like a blow on the mandible, may be transmitted to the base of the skull, fracturing the weakest portion namely cribriform plate of ethmoid. Another example is transmission of force upward through spines after a fall from height on feet or buttocks fracturing base of the skull.

Rowbotham divides mechanism of fracturing of skull bones into; **local deformation** at the site and **general deformation** of the whole skull.

Local deformation at the site occurs, if the force applied is sufficient to cause crushing of outer table into diploe or a bend of the skull bone. Sequence of events at the site of impact is formation of a shallow cone. Apex of cone stretches the inner-table and compresses the outer table. At the periphery of the cone convexity of the bend is directed outwards. If the distortion is beyond the strength of the bone, a fracture confined to the inner-table at the apex of cone results. If force is greater than the strength of both inner and outer tables of the skull, both fracture. Inner-table at the apex of the cone fractures before the outer table, whereas at the periphery the outer table fractures first. Extension of the break both of inner table at the apex to the outer table and at the outer table at the periphery to the inner-table completes break in both tables and cause depressed comminuted fracture. Fracture line in such depressed comminuted fracture tends to run radially from the

central point at the apex of the cone to the periphery and the fracture lines also tend to run in a circular manner. (**Fig 6.11**)

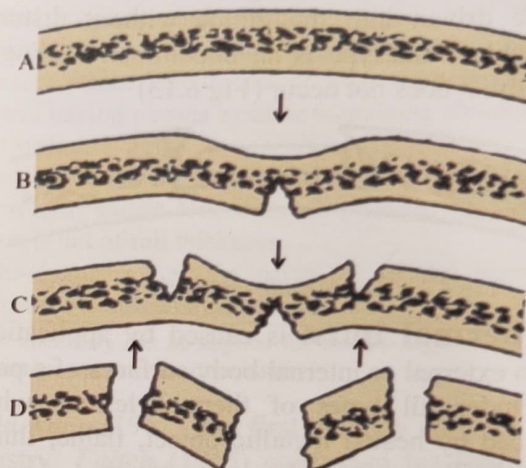


Fig 6.11: Fracture by local deformity, starting from **A.** Normal bone **B & C.** Start of fractures of inner and outer tables **D.** Precipitating comminuted depressed fracture.

General deformation of whole skull occurs due to compression of the skull. When skull is compressed in one plane, it behaves as an elastic sphere and bulges out in other plane, where fracture occurs. Examples of this mechanics are compression of skull of infant by forceps during delivery and head in traffic and industrial accidents. Skull when compressed laterally, it elongates in its vertical and longitudinal plane, producing fractures in these planes. These fractures are usually fissured ones occurring at parts of skull distant from actual site of application of force. Complication of the fracture of the inner-table leads to the development of adhesions between dura-matter and brain substance and may precipitate traumatic epilepsy. (**Fig 6.12**)

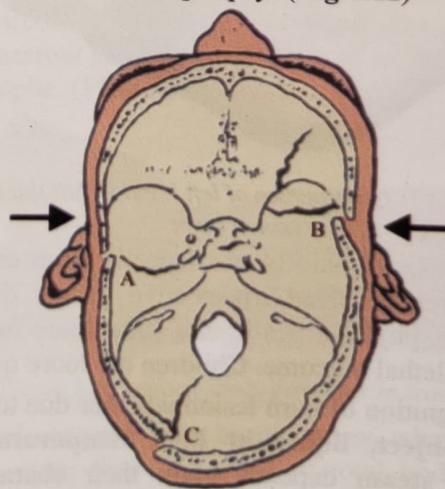


Fig 6.12: Skull bone fractures at sites **A, B & C** caused by general deformation during bilateral compression

Moritz claims that if skull is compressed, spongiosa between the inner and outer tables being fragile, a circumscribed segment of the outer table may be driven into the diploe without disturbing inner table. This type is an uncommon finding and generally, it does not occur (**Fig 6.13**)

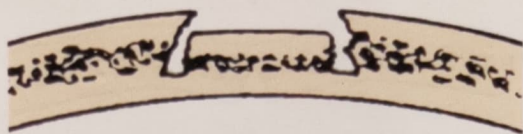


Fig 6.13: Outer table crushed into diploe

Thermal burn is caused by application of heat to external or internal body surfaces of a person. It includes all types of thermal lesions whether produced by heated metallic object, flame, fluids at or near boiling point and pressure steam.

Progressive stages of thermal lesion are redness, which appears at once, followed by blistering of skin, which takes some time to appear. Pricking and removing of blister leaves a pink raw surface from which fluid oozes. These lesions do not bleed. After few hours, there will be leucocytes infiltration and area may readily get infected followed by appearance of pus and granulation tissue. Hypertrophied scarring occurs in partial thickness burn and contracture in full thickness severe burns, which may follow months after the injury. (**Photo.6.17**)

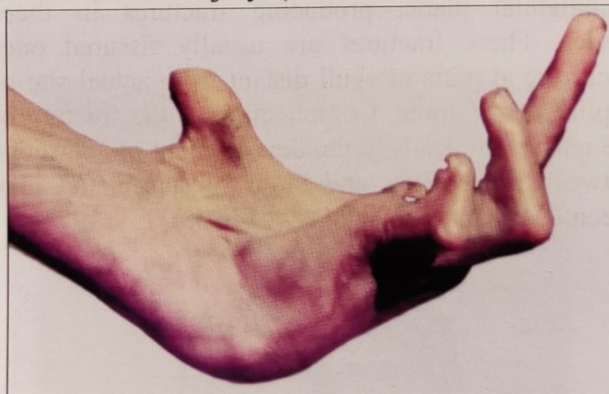


Photo 6.17: Contracture of left hand in full thickness severe burn

Prognosis of skin burns depends upon extent of surface area involved irrespective of the depth of burn. Age, physical health and immediate treatment influence lethal outcome. Children die more quickly.

Recognition of burn lesion whether due to **flame**, **heated object**, **liquid at high temperature** and **pressure steam** depends upon their characteristic appearance:

Flame and heated object lesion is dry lesion, which does not bleed and feels hard to touch. It is a very painful injury. Erythema appears immediately, followed by development of areas of coagulation and roasted patches of both skin and deeper tissue. Use of electric cautery is based on this property of coagulation of tissue including blood vessels by heat. Singeing of hair occurs. Worn clothes show burning. There will be deposit of carbonaceous material in air passage especially if live-victim is trapped in flames. Vesicles in most cases do not appear in such burns and if they do appear, their size is small and extent is minimal. (**Photo 6.18 & 6.19**)



Photo 6.18: Flame burnt corpse of female having burnt cloths, skin erythema and vital demarcating line between burn body area and healthy tissue



Photo 6.19: Flame burnt portion of child's corpse showing roasted patches at leg, groin, abdomen and vital line

Liquid at high temperature and **pressure steam lesion**, on the other hand, show erythema and large size vesications. Both clothes and hair do not show burning or singeing. Instead, they become wet with the type of liquid (milk or oil). There will be no deposit of carbonaceous material in the air passages. (**Photo 6.20 & Table 6.5**)



A



B

Photo 6.20: High temperature liquid /pressure steam burns lesion **A**. Multiple vesicals with erythema on arm **B**. Erythematous dermis of leg after removal of epidermis

Table 6.5:

Features of flame and hot liquid burns

Characteristic	Flame	Hot liquids
Erythema	Present	Present
Area of coagulation	Present	Absent
Roasted patches	Present	Absent
Vesication	Rare	Extensive
Size of vesicles	Very small	Large
Singeing of hair	Present	Absent
Condition of clothes	Burnt	Soaked

Ante-mortem burn recognition depends upon presence of vital reaction. It is a complicated issue, because there is no sharp line of distinction between the life and death. Cells or organs continue to remain viable for a variable period after clinical death. In the case of skin, the period is about ten to twelve hours. Wright (1850) pointed out that as long as the dead body is still warm, the fire flame effect of skin is similar to that of observed during life. Different forms of skin vital reactions in burns due to different agents can easily be detected both by naked eye as well as microscopy. (**Table 6.6**)

Table 6.6:

Skin vital reaction

Naked eye

- Heated objects and flame produce well marked reddening, 1/4 inch in width, bordering the lesion
- Pressure steam and liquids at high temperature cause blisters having plasma exudate containing albumin. Raw skin surface is pink

Microscopy

- Burnt skin shows leucocytes infiltration, provided the lesion is not of full thickness
- Histo-chemistry* at the periphery of the burnt skin indicates increased enzymes reaction

*Histo- chemistry can be applied for medico-legal distinction of ante-mortem and post-mortem burns.

Rackaiio (1961) was first to study enzyme histo-chemistry. **Faltch** (1965) confirmed his findings in the human skin and **Mallik** (1968) applied them to skin burns. Chosen study enzymes were alkaline phosphatase, acid phosphatase, Lucien amino-peptidase and non-specific esterase. Drawn conclusions were as follows:

- Increase in enzyme reaction at the periphery of the burn, which can be detected much earlier than histological changes.
- Changes are similar in all burns of same age and the reactions are stable to withstand period of delay between death and postmortem examination.
- Reactions are also not altered with topical applications.

Victim, while dying in fire, inhales carbon monoxide and sooty material into the air passages of lung and may also swallow these particles into the stomach. Presence of black sooty particles in trachea, bronchi and stomach and the presence of more than 70% carbon monoxide in blood and other tissue like bone-marrow are strong evidence of an ante- mortem catastrophe. (**Photo.6.21**)

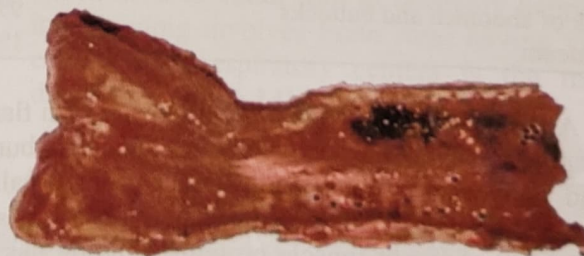


Photo.6.21: Black sooty particles in trachea

Fatal outcome from burns occurs, when involved area is more than one third of total body surface. Most serious cases are those in which the trunk is

involved. Chronological order of thermal burn complications upon the body as a whole are:

- Immediate primary shock due to pain
- Secondary shock with circulatory collapse due to loss of fluid and hemo-concentration
- Death occurs either within 24-36 hours due to toxemia (production of toxins by burnt tissue) or after many days, due to infection and septicemia

Medico-legal certification important criteria of thermal burn are extent of body surface involved and depth of the burn. Generally two depths are referred to in the medical certificate; superficial, which does not involve full thickness of skin and others, which involve full thickness of skin and deeper tissues. Other important points of medico-legal certification in such cases are:

- Recognition of type and cause of thermal lesion
- Distribution of burnt area consistent with history of the case
- Extent of burnt surface and its relationship to death
- If death occurs, whether burn lesion is ante-mortem or otherwise

During forensic certification, Medical Examiner takes advantage of the **rule of nine** to calculate the extent and percentage area involved bearing burns of the body surface. (Table 6.7)

Table 6.7:

Rule of nine

Face, neck and scalp	9%
Arm, forearm and hand of right side	9%
Arm, forearm and hand of left side	9%
Front of thigh, leg & foot of right side	9%
Front of thigh, leg & foot of left side	9%
Back of thigh, leg & sole of foot of right side	9%
Back of thigh, leg & sole of foot of left side	9%
Front of chest	9%
Back of chest	9%
Front of abdomen	9%
Back of abdomen and buttocks	9%
Perineum	1%

Autopsy findings; externally there are skin flame burns of different severity. Clothes are also burnt. Dead body acquires a specific boxer attitude called **pugilistic attitude** due to heat coagulation and shortening of flexor muscle proteins. Finding has no significance, as even a dead body will attain it.

Internally findings are marked pallor of liver and kidneys. **Curling ulcers** develop in gastric and duodenal mucosa, which occur due to pain and stress

accompanying severe burns. They are circular less than 1 mm. in diameter and superficial and should be differentiated during autopsy from intense hyperemia, even superficial erosion, which occurs during agonal period within minutes.

Postmortem artifact, which are produced during fire needs recognition and should be located. They are *flaking bone fracture* aided by muscle shortening, protein coagulation and bends at joints, *skin splits* for the same reason and *extra-dural heat hematoma* in the immediate vicinity of external burn of head. Heat hematoma is light in color and has a spongy and honeycomb appearance.

Medico-legal importance of burn lesions is that they are invariably caused as a consequent of an accident at home or in industry. Criminal infliction of thermal burn with lit cigarette or solid bodies at elevated temperature occurs during torture, especially by police. Homicidal or suicidal cases though are rare, yet cannot be ruled out.

Destruction of the murder victim's body by fire to conceal crime and eliminate the evidence is the oldest method. Therefore burnt corpses require careful scrutiny of available human remains from this point of view. Examples are two cases (Photos 6.22 & 23)



Photo 6.22: Post mortem burnt male corpse without vital reaction, cause of death suffocation by cloths stuffing into mouth, which got speared from burning being in mouth cavity



Photo 6.23: Another similar corpse without vital reaction, cause of death strangulation by rope around the neck, which got speared from burning by chin overlap

Electrical Lesion is caused to humans at home, in industry and occasionally in hospital all over the world. It is an important accidental injury. Domiciliary accident occurs because of defective wiring and appliances. Causation of local lesion depends upon **electricity voltage** and **electrical considerations**:

Electricity voltage safe range is 100-110 at 60 cycles and fatal range is just about 200. Different electricity voltages are used in Pakistan; domestic from 220-240V, industry including railways 600V-1200V and transmission lines 11KV. Contact with above mentioned three voltages produce three effects:

- **'Hold-on effect'** at 220-240V (domestic) causes muscle spasm, responsible for non-release of live conductor
- **'Throw-off effect'** at 600V-1200V (industrial) reduces period of contact, responsible for survival of victim
- **'Arcing effect'** at 11KV (transmission lines) requires no contact for causing lesion.

Electrical considerations having intimate relation with outcome are; **body resistance, electricity pathway and contact with earth.**

- *Body resistance* role depends upon whether body tissue is comparatively dry or wet and otherwise vulnerable to the effect of electrical current like nervous and muscular tissue.

- a) Body tissues in respect of fluid content are blood vessels and skin of palm and sole. Blood vessels having maximum fluid offer almost no

resistance and act as good conductor. Skin of palm and sole, being relatively drier offers resistance and generates heat causing thermal lesion at point of contact. Further loose contact additionally generates spark and causes metallization instead of pure burn.

- b) Brain and spinal cord are more vulnerable producing minute hemorrhages in brain matter and passage of electric current through spinal cord cause injury to cardiac and respiratory centers in the medulla.
- c) Cardiac including respiratory muscles offer negligible resistance and respond by strong contraction. From clinical point of view, electrical contact causes long periods of apnea, ventricular fibrillation and cardiac arrest.
 - i) Low voltage produces myocardial fibrillation due to direct action on pace maker, conducting system and actual muscle fibers
 - ii) High voltage either causes heart muscle to fibrillate or then becomes nonfunctional or produces spasmodic contraction and asystole.

When current is broken, ventricle may jump back to normal rhythm and arterial blood pressure restored. Presence of cardiac disease, physical fatigue and intoxication, all predispose to early death.

- *Electricity pathway* through body of the victim are four:

- i) From one hand to opposite foot passes across chest in diagonal direction involving both heart and respiratory muscles is dangerous
- ii) & iii) From one hand to other and similarly from one foot to other involves no vital organ and are not dangerous
- iv) From head to either foot as normally happens in lightning involves brain stem having vital cardiac and respiratory centers is the most dangerous, (Fig 6.14)

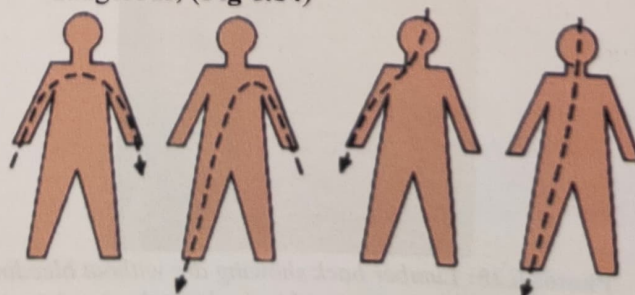


Fig 6.14: Electricity pathways through the body

- 'Contact with earth' and its role; better the contact between person and earth, more serious is the outcome. Bathroom situation is very dangerous due to both moisture and perfect contact of water pipes.

Electrical lesion occurs on body skin at both points of entry and exit and differs in appearance weather caused by domestic or industrial voltage current. Domestic lesions are further divided into two types; **loose** and **firm contact lesion**.

Loose contact lesion, also called *spark lesion* is an area of dry burn of varying size showing either area of blackening, separation of epidermis or burning due to heat emitted at the point of contact. It has a central parchment surrounded by hyperemia. Microscopically, there is shrinkage of superficial cells of epidermis showing multiple pricked or pitted metallization with metallic particles liberated from the conductor, which get embedded in the tissue. All such lesions do not show the full picture.

Posted are two cases of i) a girl who committed suicide following a suicidal pact, tied her right wrists with positive and left wrist with negative electrical wires and put the switch at on-position and died immediately (**Photo 6.24**) and ii) a male whose lumber region back remained in loose contact with live wires for some time (**Photo 6.25 & 26**)



Photos 6.24: Massive blackening around right and slight with erythema around left wrist without bleeding from live lose contact of electrical wire



Photos 6.25: Lumber back showing dry without bleeding epidermis separation/erythema due to loose contact through shirt with live electrical conductor



Photo 6.26: Loose contact exit lesions **A.** Circular charring and blackening surrounded by hyperemia on ventral surface of foot **B.** deformed metallic stud of sole due to passage and earth contact

Firm contact lesion usually occurs on working finger pads and is very characteristic in appearance. It is a raised blister containing either gas or a little fluid. Depth of the lesion is invariably full thickness of skin. Area of destruction is visible as a white slough surrounded by a rim of bright red color caused by passage of current and also due to capillary injury.

Industrial lesion occurs either at a point of contact with high voltage wire due to hold on effect or arcing, which actually does not require contact. Arcing effect to an approaching person produces flash burns. Both lesions resemble advanced thermal burns involving large areas of skin as seen in cases of injured linemen working at high-tension transmission lines. Lesions are extensive, varying in appearance from burns by highly heated object, to crocodile skin, to completely carbonized tissue. (**Photo 6.27**)



Photo 6.27: Massive industrial burn lesions **A.** while holding conductor on hand **B.** due to earth contact on foot

Death during electrocution may occur as immediate and delayed. Immediate death is due to vagal inhibition by fright, ventricular fibrillation due to effect on heart muscle and asphyxia due to paralysis of modularly vital centers or respiratory muscles. Delayed death occurs due to complications of burns and their toxic effects. Homicide and suicide is possible.

Autopsy findings depend upon the mode of death. External lesions are burns due to contact with conductor both at the point of entry as well as exit. Internal lesions are due to passage of electrical current through the body. Neurological brain and spinal cord lesion are focal petechiae hemorrhages affecting medulla and gray matter mostly in judicial electrocution. Brain tissue also shows irregular tears or fissures.

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CHAPTER 7

7. Forensic Aspect of Wounding (Part 2)

Introduction to Fire-arm weapons is necessary, because of their more lethal effects and their ability to kill multiple people at a far distance. They are last of invented dangerous weapons having multiple causative factors. It is unfortunate that efforts are on to further improve their lethality by increasing bullet speed, control over their availability is not propionate and these weapons are replacing rapidly previously used weapons.

Proper understanding of cause-effect relationship of wounding by fire-arm/bomb to people within the vicinity would require detailed information about their design, physics of propulsive forces and elements used. Firearms weapons as a group contain weapons like revolver, riffle, shot-gun and bomb. Study of understanding of their cause-effect relationship of wounding with them is based upon a knowledge of special **ballistics** subject having three components:

- **Interior ballistics**
- **Exterior ballistics**
- **Wound-complex ballistics**

Interior ballistics deals with forces of propulsion of projectile (bullet/shot charge) dependent upon design of **barrel** and **cartilage** and remains limited within the bore of barrel till its exit from the muzzle end. What happens within the barrel is a **chain of events**.

Barrel from point of view design is either long or short, has two ends; breech and muzzle and a bore; smooth and rifled. Smooth bore may be a true cylinder or choked while rifled one has grooves and lands, which go spirally throughout the length of the barrel.

Cartridge design has many parts consisting of a case having primer, powder charge, wad and projectile, which fits suitably breech end of barrel. Primer is situated at the base having ability to fire and its composition is barium, lead and other metallic salts. Powder charge varies in its physical and chemical composition to control its burning rate, thus of two types; black consisting of potassium nitrate, sulfur and charcoal and smokeless consisting of nitro-cellulose and nitroglycerine. Wad is made of cork or some other material to acts as a partition between the powder charge and projectile. Projectile is generally

made of lead and is of two types; bullet that is single and shot-charge, which consists of many small pellets. (Fig. 7.1)

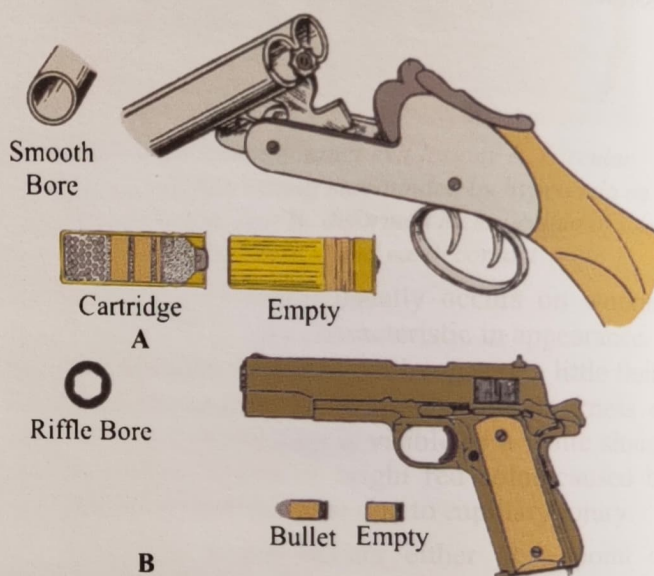


Fig. 7.1: Firearm design **A.** Twin-barreled smooth-bore shot-gun and cartridge **B.** Semi automatic rifled-barrel pistol and bullet

Chain of events takes place in six stages within the bore of barrel:

- Strike of firing pin at the primer begins the chain
- Powder charge gets ignited liberating gases at a very high temperature. Composition of gases in accordance with quality of powder and generally are carbon dioxide, carbon monoxide, nitrogen, sulfurated hydrogen and methane. One-grain weight of powder generates 200 to 900 ml. of gas.
- Chamber pressure increased sharply from zero to four to six tons for a revolver and pistol and about 20 tons for a rifle due to production of gases.
- Chamber pressure acts equally in all directions upon breech end of the barrel through the cartridge case, including base of projectile through partition wad.
- Strength of metal of firearm resists this pressure and forces projectile to move forward through the bore accelerating continuously. In case of a rifle, bullet besides acquiring acceleration is subjected to groove effect forcing the bullet to spin increasing its rotation upon its axis during forward motion.
- Exit of projectile from the barrel brings the chamber pressure to zero ending chain of events. pellets. (Fig. 7.2)

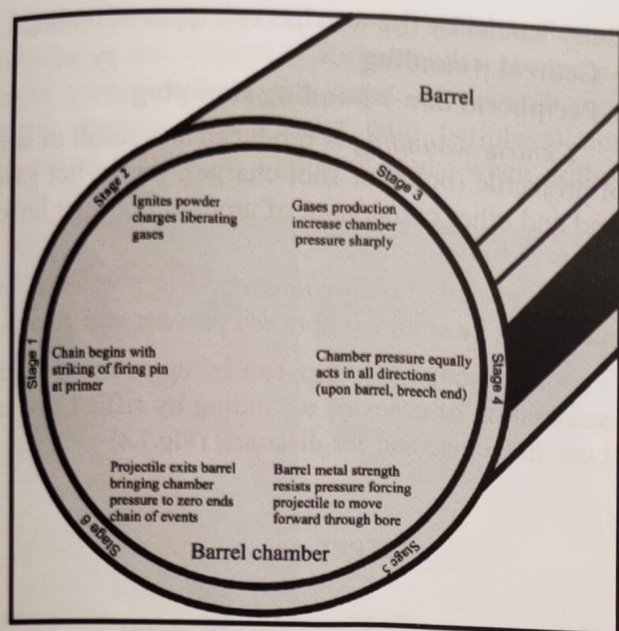


Fig. 7.2: Six serial chain of events stages within barrel chamber

Exterior ballistics deals with forces that act on bullet during its flight from the moment it leaves the barrel to place of impact on the target. During flight, there is interaction between the forces originating from projectile motion, those present in the medium and force of gravity. Forces originating from projectile motion are its velocity having two components, speed and direction. Projectile velocity at the muzzle end is either low (less than 1200 feet per second) or high (above 2000 feet per second), depending upon with type of firearm. (Table 7.1)

Table 7.1:

Projectile velocity at muzzle end

Revolver	600 to 900 feet per second
Pistol	1200 to 1400 feet per second
Rifle	2000 to 3000 feet per second

Sooner lateral support of barrel ends, forces of medium take over making the bullet unstable especially in earlier part of its flight. Forces present in the medium are air resistance, which is negligible and force of gravity, which draws the bullet towards earth. It forces line of flight of bullet to follow a curved path known as **bullet trajectory**, very slight for a short distance not even appreciable, but becomes apparent over a long distance. Further tip of the bullet follows the axis, but its tail describes circles around line of flight for some distance from the muzzle end called **bullet tail-wag**. Distance of tail-wag from muzzle end for a pistol is 60 yards and for a rifle 200 yards. After this distance bullet becomes stable and settles down into gyroscopic progression.

Wound-complex ballistics is the resultant effects of **fire-blast** at the target on human body after coming out of the barrel of firearm. Fire-blast, besides projectile (bullet) or short charge, which has its diameter, shape, weight, rigidity and terminal velocity also contains other elements like flame, hot explosive gases, smoke and some other components of ammunition such as wad, unburned powder and grease taken by the bullet from within the barrel.

Fire-blast effects on the target can be understood by meticulously observing interactions between above stated contents of fire-blast and body tissues of part struck. Factors in the part struck are resistance of the tissue dependent upon its nature, density and architectural design. The most important factor is projectile (bullet) and its velocity either **low** or **high**.

Low velocity bullet while striking the body part, it pushes and rotates to produce an indentation in soft and elastic tissues like skin and finally perforates it. It allows passage of the bullet. During passage through the tissue, bullet energy radiates laterally causing damage proportionate to diameter of the bullet. It is represented as path or track of the bullet.

High velocity bullet, on the other hand, additionally produces a temporary cavitation in soft tissues pushing them more laterally over and above the damage caused by the low velocity bullet. Energy in the bullet is very high and it tends to dissipate in the surrounding tissues more effectively in radial fashion creating instant cavitation. Period of cavitation is extremely short and soon after the passage of the bullet, tissues recoil and collapse back leaving a permanent cavity or damage, which is larger than the diameter of low velocity bullet (Fig. 7.3)

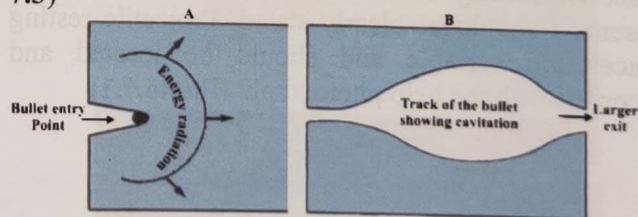


Fig. 7.3: Bullet path showing A. Energy radiation B. Cavitation and larger exit

When high velocity bullet strikes a bone, depending upon its strength, the bullet shatters its target more effectively. Greater the density of the tissue, greater is the amount of energy discharged. Rapid transmission of large amount of energy fractures bone and ruptures other tissues situated even at considerable distance from the bullet path. When bone fractures into pieces, its bony speculae

act as secondary projectiles and spread in various directions causing many secondary tracks.

When a hollow viscus containing fluid is hit by a high velocity bullet, its contents get separated into small particles, which get displaced explosively in all directions away from the bullet path and behave as secondary projectiles. In conclusion, it may be stated that characteristic of damage by high velocity bullet is disintegration and disorganization of large areas of the tissue immediately adjacent to the track as well as surrounding it.

Correct interpretation about identification of the firearm weapon, bullet trajectory through the human body, cause and manner of death all depend upon proper analysis of wound-complex. A word of caution must be kept in mind that there are now numerous firearms weapons having their specific ammunitions, interpretation of wound-complex produced by them individually may become difficult task.

Firearm wound-complex is name allocated to some-total resultant damage findings of fire-blast on target. It has four parts:

- **Entry wound**
- **Trajectory with direction**
- **Bullet resting place**
- **Exit Wound**

Forensic requirement of certification of fire-arm complex should include description of all four parts. Trajectory with direction needs proper exploration for its location and should be preserved by placing radio-opaque material and x-ray recording of the finding enclosed with certificate. If any of them like place of resting of bullet and wound of exit are absent, it should be clearly stated. Projectile resting places are variable and should be located and recorded with the help photograph. (Photo.7.1)

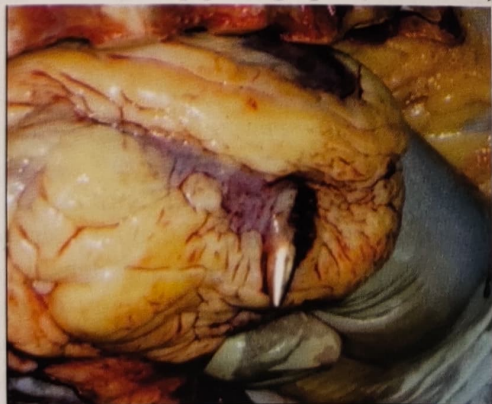


Photo.7.1: Projectile resting place, bullet embedded in heart

Entry wound by fire-arm has two types of findings:

- **Central wounding**
- **Peripheral non-wounding stamping**

Central wounding is produced as a result of strike of projectile (bullet or shot-charge), flame, hot gases, wad and other component of ammunition like broken pieces of bullet.

Peripheral non-wounding is caused by imprinting by smoke, unburned powder and grease.

Above stated findings can be appreciated during examination of cases of wounding by rifled fire-arm at contact, close and far distance. (Fig.7.4)

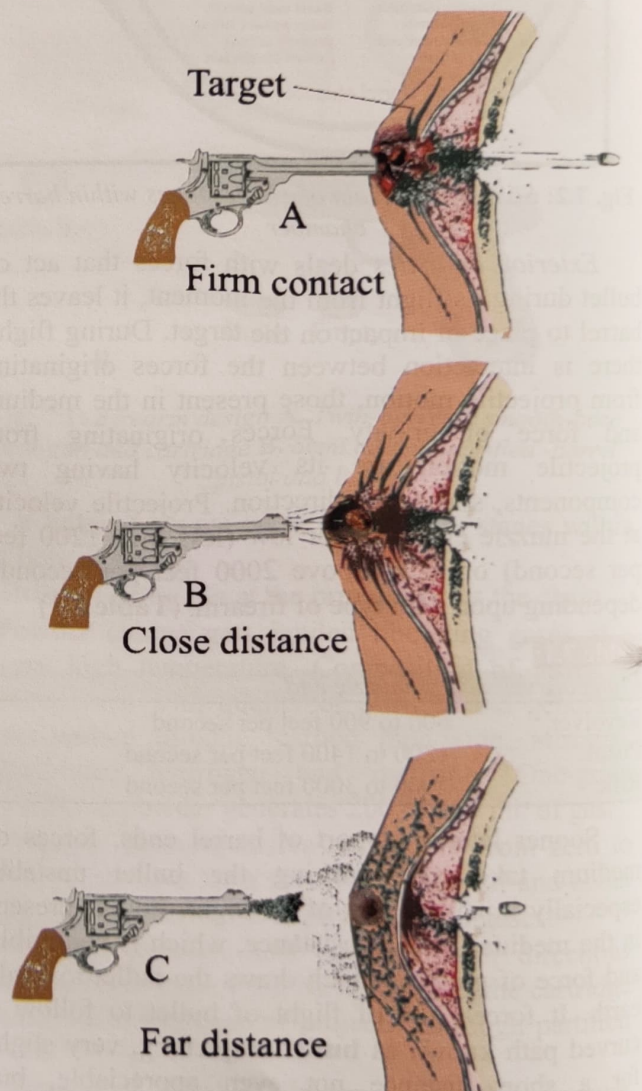


Fig.7.4: Rifled fire-arm wound target effects: **A.** Firm contact having central wounding mixed with flame burning and soot/gunpowder within tissue **B.** Close distance having central wounding partly stamped surrounding skin with soot/gunpowder **C.** Far distance having central wounding without soot/gunpowder over skin

Entry wounds descriptions by rifled bullet and shot-charge are different. Rifled bullet produces a single central hole at the target whereas shot-gun causes multiple holes along with peripheral non-wounding imprint on cloths or body when without cloths. (Photo 7.2)



Photo.7.2: Entry wounding by rifle bullet showing single central hole surrounded by non wounding imprint on shirt and adjacent lower part of neck

Rifled weapon entry wound is typically circular hole with inverted margins like poking of a lead pencil through skin. It is becoming less common since replacement of low velocity bullet with high velocity. Hole of entry wounding is smaller in size than bullet, when it perforates skin while it is stretched due to push before making the hole. Larger jagged irregular wounding more than diameter of the bullet occurs both due to tail-wag effect and also by explosive blow back effect of the gases against hard bone like on forehead and face (chick bone).

Shape of central hole on the skin gets modified depending upon angle and distance of fire. It may be circular, oval, elliptical, stellate or an elongated furrow. Other characteristics of entry wound on skin at or around the hole of bullet are abrasion, bruising, flame scorching, powder tattooing, smoke blackening, and grease effect and gross splitting.

Abrasion is always marginal and appears as a collar. It is usually present when the strike is from some distance. Rubbing of screwing motion by bullet of margins of the wound of entry produces it. When bullet enters perpendicularly to skin, abrasion ring is circular and uniform. When it enters obliquely, it presents more of an elliptical shape, longer axis pointing to the direction of the approach. When the angle is very small, there may be a furrow through the skin before complete entry into the tissue. Tangential strike produces only an elongated furrow in the skin and tissue.

Bruising mainly occurs at or around the wound of entry due to general tissue trauma. Pressing of the muzzle end against the body tissues may produce it. Gases of the blast may get pushed into or under the skin ballooning and bruising them.

Flame scorching is present both in contact and close range wounds. Flame from the muzzle end reaches a few inches in the case of revolver and about a foot in a case of shotgun. Depending upon coverage of area by hair, it will show scorching of the hair and skin. Surface hair may be completely removed by burning or may be shriveled and clubbed owing to burning and melting of the free ends. Skin itself may also show characteristics of a burn ranging from reddish brown flare to scorching mainly at the free margin of the wound of entry.

Smoke blackening is mainly due to black powder. It is less marked or even absent with smokeless powder. At contact or near distance, the carbon containing gas gets deposited as minute particles upon the clothing or skin around the wound of entrance. Smoke mark may indicate range and direction of the fire. Beyond a yard, it is absent. Powder tattooing or stippling is present around the wound. These marks resemble peppering and are due to unburned or partially burnt powder particles. They are far more common with black powder. Beyond two yards, tattooing is not present

Grease mark is present only at the margin of clothes or the wound. The bullet removes such substance from the barrel by wiping and deposits it on the margins of the wound. (Photo.7.3)

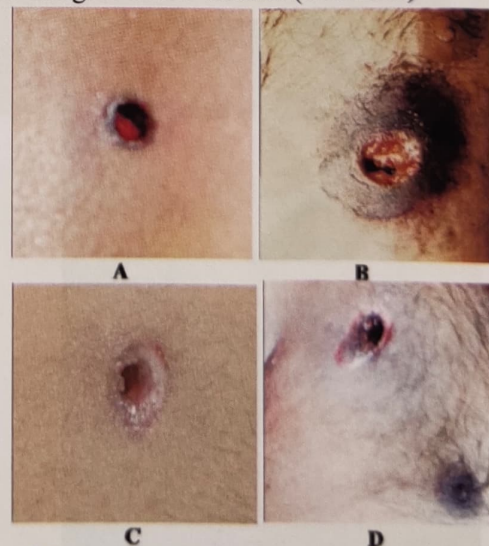


Photo.7.3: Bullet entry wound margins characteristics A. Flame scorched entry margin B. Powder stamping around entry C. Collar of abrasion & D. Elliptical entry indicating angle of fire

Gross splitting of skin generally occurs with high velocity bullet and contact wound of low velocity bullet. In latter case, gases of fire-blast from muzzle end pass into the tissue under pressure distending and lacerating skin and subcutaneous tissue. If there is no hard structure like bone under the skin, gases easily get dispersed into the tissues. When there is hard bone as in scalp or cheek, it resists entry of gases, which return with extreme force; **blowback phenomenon** causing stellate or ragged wound with everted margin. Occasionally bullet exits through original entry wound. (Photo.7.4 & 7.5)



Photo.7.4: Rifled firearm Stellate shaped entry wound on forehead



Photo.7.5: Rifled firearm Stellate shaped entry wound on face cheek

Trajectory with direction is track between entry and exit wound. Track shape and diameter depends upon velocity of the projectile and type of tissue through which it passes. It may be a single uniform course proportionate to diameter of the projectile while it passes through soft tissues or a changed course in shape, size and direction if projectile hits a hard object like bone. Later course has two distinct portions; initial primary through soft tissues and subsequent secondary through hard bone and remaining soft tissue. Primary portion with low velocity bullet through soft tissues is usually proportionate or slightly smaller to the diameter of the projectile and secondary either is larger or multiple due to broken bone pieces having little relation to diameter of the projectile. If site of ricocheting prior to entry is different, both entry wound and its path will be totally unpredictable and may assume a bizarre shape. It is important in such cases that projectile be examined for possible foreign inclusions originating from intermediary target (Fig. 7.5 & 7.6)

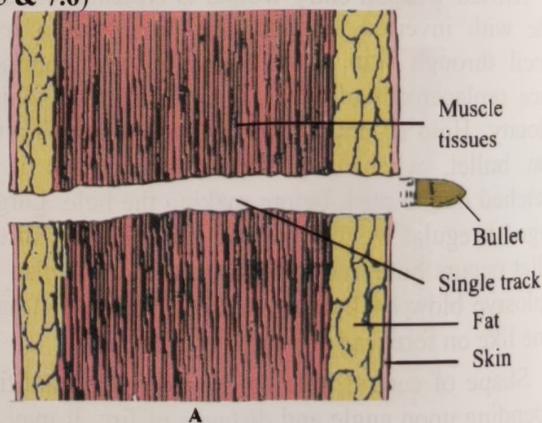


Fig. 7.5: Projectile uniform track through soft tissue proportionate to its diameter

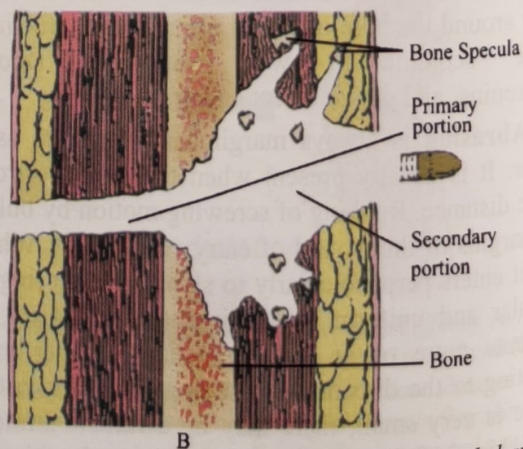


Fig. 7.6: Projectile changed track in size and shape having multiple courses through bone having no relation to its diameter

Exit wound by rifled bullet in soft and hard tissue presents different appearances. Soft tissue exit is ragged wound having everted margins, comparatively larger than entry without fire-blast imprint effects. Body hard tissues are bones of different character like short, long and plate as in skull. Only skull

shows characteristic entry and exit rifled bullet holes, which indicate direction of trajectory. Entry hole is a simple hole, whereas exit shows beveled margins. Holes may also accompany radiating fractures traveling away in the direction of dispersion of energy. (Photos.7.6)

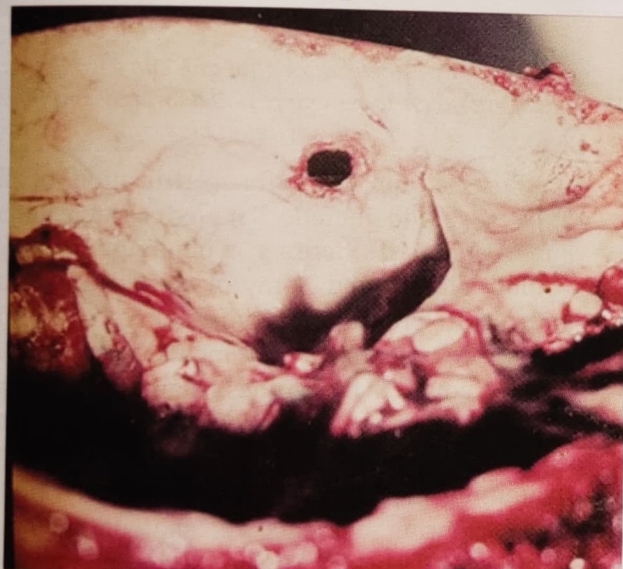
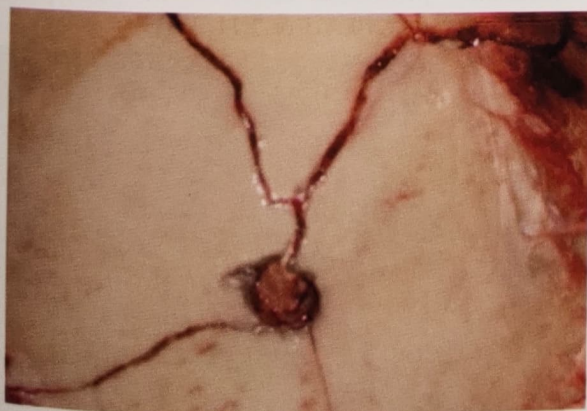
**A****A.1****B****B.1****C****C.1**

Photo.7.6: Rifled bullet holes on external/internal surfaces of skull **A & A.1** Entry holes with clear margins **B & B.1** Exit holes with beveled margins **C & C.1** Entry and exit holes with radiating fractures

Summary of differences of character of entry and exit wound is tabled at. (Table 7.2)

Table 7.2:

Differences of entry and exit wounds

Character	Entry	Exit
Diameter	Smaller or equal	Larger
Shape	Regular (circular/oval/stellate)	Irregular
Margins	Inverted	Everted
Bleeding	Less	More
Fire-blast imprint	Present	Absent

Entry wound by shotgun differs in appearance from rifled wound. Main difference is number of holes i.e. rifled wound has single hole and shotgun many holes depending upon distance of fire:

- Contact wound makes single en-mass entry with burnt irregular margin
- Short distance wound makes a pattern having central en-mass entry with a few peripheral holes
- Far distance wound lacks central en-mass entry and pellets with wider dispersion make individual holes almost of the size of each pellet without charring. Diameter of dispersion has relationship with range. Wound in inches is equal to distance between muzzle end and target in meters. Maximum effective range of shotgun is about 20 meters. (Photos. 7.7 & 7.8)



Photo.7.7: Close distance shot gun entry wound on face causing central en-mass entry and pellets making two holes due to limited dispersion



Photo.7.8: Far distance shot gun entry wound on chest causing no en-mass entry; pellets widely spread making holes without charring

Forensic protocol for certification of fire-arm injuries should include detailed written description; photographs of victim's wounding area with and without clothes and X-ray of wounded part to locate and record presence of short-charge within body of corpse are essential requirements. Further, if targeted area is covered by clothes, stained with blood and bear shot-charge hole/holes, it should be encircled with permanent marker, signed and dated by examining medical examiner to identify in the court of law during evidence. A shotgun injury case is chosen and listed below seriatim to emphasize forensic protocol requirement of photographs. (Photo.7.9 A, 7.10 A.1 & 7.11 A.2)



Photo.7.9 A: Victim's wounding area on left chest. Shirt showing blood stains and en-mass central entry with widely spread pallet holes



Photo.7.10 A.1: Same case without shirt showing en-mass central entry and widely spread pallet holes on left chest and left hand

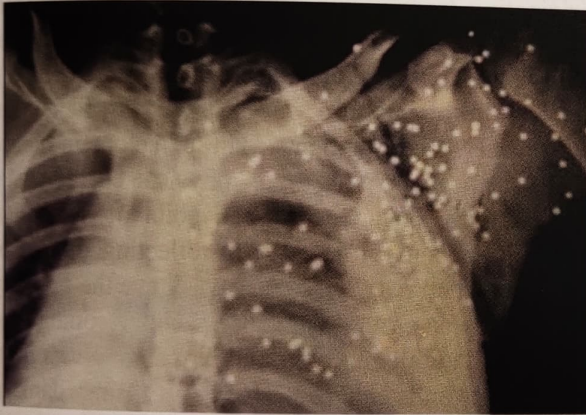


Photo.7.11 A.2: X-ray of same case showing central aggregation and widely spread pallet holes on left chest

While discussing forensic certification protocol of fire-arm injury, forensic medical examiner is advised to remember differentiation points between wounding by bullet and shot charge. (Table 7.3)

Bomb blast including suicidal bomber injuries are classed as special trauma. Mechanism of blast, resultant atmospheric changes and injuries caused to human beings within its vicinity would require knowledge about:

- **Bomb design**
- **Physics of explosion forces**

Bomb design comprises of a container, explosive material and detonation device. Container usually a pipe or glass cylinder made of any suitable material such as plastic, glass or metal that can be sealed airtight. Explosive material can be a solid, liquid or gas and most commonly used is commercial gelignite and sugar-sodium chlorate mixture. Detonation device is either time-delayed or remote controlled. Recently along with explosive material other items such as nails, balls from ball bearing or metallic pieces of different sizes are used.

Physics of explosion forces are hot expanding gases of extremely high magnitude, which increase atmospheric pressure in the region of explosion instantaneously and generate **pressure waves**. These pressure waves travel concentrically in all directions at very high speed about 21,000 km/hour. Like sound waves, the pressure waves have the ability to flow around barriers and also get reflected by them. The pressure is very high at the front of the wave and the maximum differential between the pressure in the region of explosion and the normal atmospheric pressure is called **peak over-pressure**.

It is measured in pounds per square inch. A partial vacuum is formed behind these waves of the peak over-pressure lowering the atmospheric pressure to below normal. Length of time between the passage of shock waves and return to the normal pressure is known as **positive pressure duration**. (Fig. 7.7)

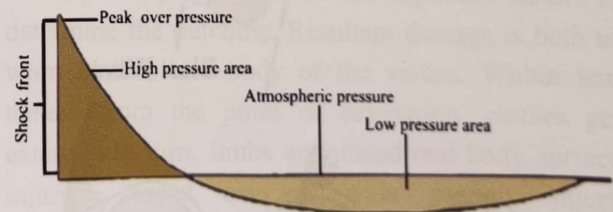


Fig 7.7: Atmospheric changes in the region of explosion

Table 7.3:

Differentiation points between wounding by bullet and shot charge

Character	Bullet	Shot charge
Number of entry wounds	Single	More than one
Shape of entry wound	Round or oval	Pattern made by pellets
Size of entry wound -	Proportionate to the diameter or larger	Small or proportionate to diameter of pellet
Margin of the entry wound	Inverted	Non specific
Imprint around the entry wound	Less prominent or absent	More prominent
Tail wag effect	Present	Absent
Track	Single	Multiple
Exit	Present in majority of cases	mostly absent

Pressure wave's front can pass through the human body tissue depending on their resistance, type and architectural design. They may pass differentially through coverings of the body, muscles and internal organs. The passage through solid organs like liver and spleen is relatively smooth producing less damage. Organs containing air like lungs and middle ear are more susceptible and are subjected to shredding effect at the tissue-air interface as the waves cross it and produce shearing movement in the other portion causing it to be bruised. Lungs show patchy alveolar hemorrhages throughout and death may occur due to respiratory embarrassment. Tympanic membrane shows reddening, bruising and perforation. (Fig. 7.8)

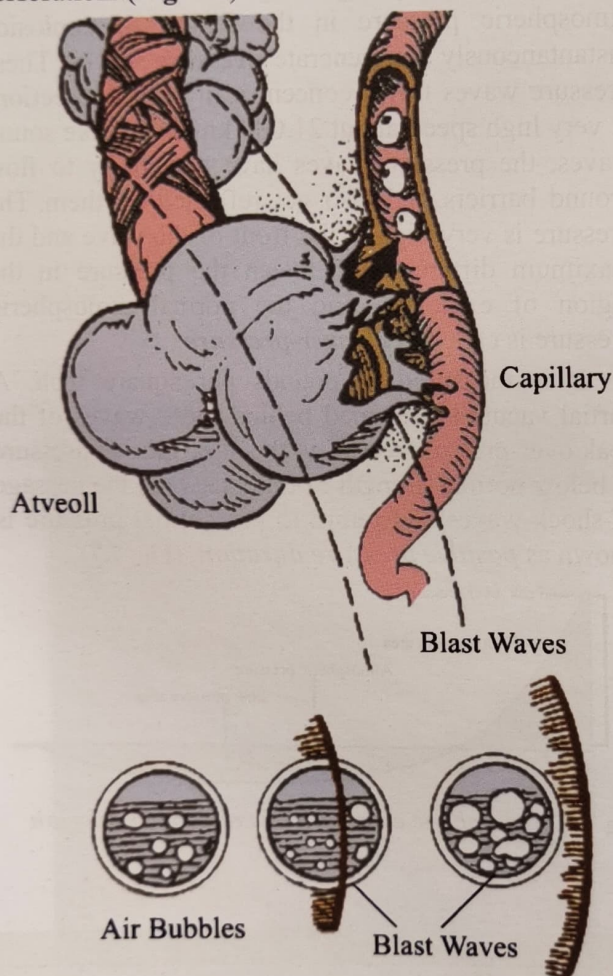


Fig. 7.8: Passage of blast waves through the soft tissue

Besides explosion in atmospheric air, it may also occur under water, which is 800 times denser and 1000 times less compressible than air. It transmits blast waves more efficiently. Injuries produced from the same blast occurring under water are far more serious and severer. (Fig. 7.9)

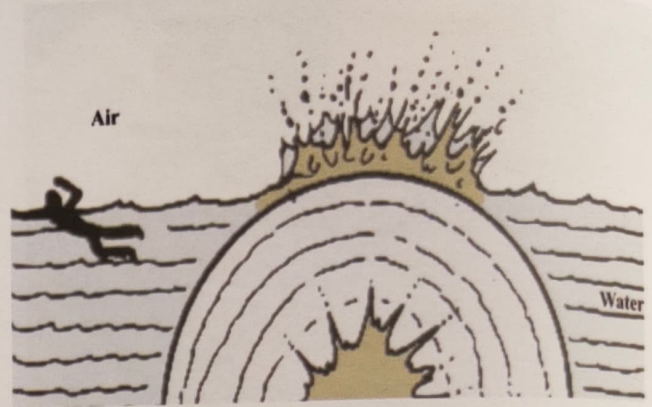


Fig 7.9: Pattern of transmission of blast waves in water

Explosion, besides blast waves, produces flame of very short duration, smoke and solid fragments originating from within the bomb and environment. The sum-total effect is conversion of bomb material and surroundings elements into a violently expanding atmosphere of pressure waves containing flame, hot gases and solid fragments. These factors influence the outcome depending upon physical characteristic of the bomb, distance between point of detonation and victims and protecting or reflecting effects of adjacent structures. Pressure waves have the property to be deflected around any barrier, which come in the way, flow laterally and join the *pressure wave's front* reinforcing and enhancing effect causing damage more severely.

These elements cause external injuries to the victims in the vicinity of blast in four ways:

- **Primary effect**
- **Secondary effect**
- **Tertiary effect**
- **Other effect**

Primary effect is direct impact of steep *pressure wave's front* travelling at a very high speed. Pressure wave's front acts like those of blunt force and produce injuries. Air over-pressure above 100 lbs. per square inch is necessary to endanger a human being:

- If the victim is in contact with bomb at the time of detonation, he is literally blown into pieces which fly in all directions for variable distances up to 200 yards. Careful search and collection of human material at site of such a case presents bizarre and senseless picture.
- Other cases, when distance between victim and bomb is about one meter, torso is grossly damaged, cloths torn and limbs amputated blown off. Beyond this range, body is not mutilated and only gets injured. (Photos.7.12, 7.13 & 7.14)



Photo 7.12: Collected blown apart body pieces of victim by primary pressure wave's front close to bomb at the time of detonation

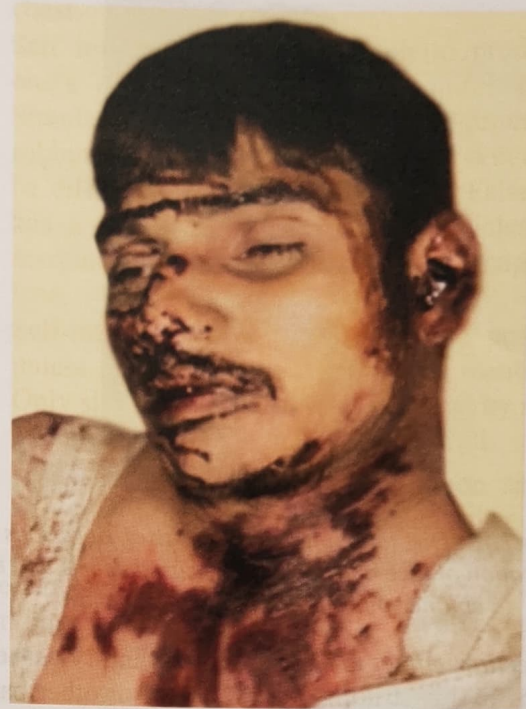


Photo 7.14: victim's body beyond one meter injured without mutilation



Photo.7.13: Victim's body within one meter range of bomb face, chest and abdomen grossly wounded, right arm blown off and shirt massively torn

Secondary effect is an indirect consequence in the form of injuries received by the victims due to impact of debris energized by the blast. Debris consists of **primary missiles** originating from components of the bomb itself and **secondary missiles**, which are nearby articles thrown into flight by blast. Victim's distance from point of detonation and nature and velocity of flying fragments are important factors to determine the outcome. Resultant damage is both to worn clothes and body of the victim. Within few meters from the point of detonation, clothes get extensively torn, limbs amputated and body surface injuries spread over a wide portion. Injury characteristics are either in the form of **dirt tattooing** or **triad of bruises, abrasions and small lacerations**. Bruises and abrasions are circular, two-ten mm in diameter and in some cases, may coalesce together to give the skin a purple discoloration. The size of the lacerations is slightly larger unto 3 cm in diameter. In cases where victims are beyond few meters of the blast, tattooing effect disappears. Only large fragments may get impacted in various parts of the body or pass into or through body cavities. (Photos. 7.15)



Photo.7.15: Dirt tattooing/triad of bruises, abrasions and laceration of face and neck by energized debris and two splinter injuries on shoulder and chest

Tertiary effect is also an indirect injury caused to victims by his striking against a wall or other barrier under the effect of pressure wave front. On most occasions victim is lifted off the ground and propelled against the barrier precipitating deceleration effect to the contents of his body cavities.

Other effect on the victim is due to the **explosion atmosphere** having flame and hot gases due to combustion of clothes and surrounding items; inhalation of noxious gases and falling masonry structures. Ionizing radiation effects are only present in cases of nuclear blasts.

Original flame due to detonation is so momentary that secondary fire masks its effects. Those caught inside collapsing buildings sustain bruises, abrasions and lacerations of nonspecific kinds, which must be differentiated from those due to blast effect. These victims die mostly either due to multiple injuries of demolition or crush asphyxia.

Suicidal bomber, wearing suicidal vest containing explosive material mixed with multiple metallic items, which act as projectile (nails, iron pieces of different sizes, balls from ball bearing and occasionally bullets) comes to scene to do the job and die. He is determined to cause maximum damage to people. Detonation device is either under control of suicidal bomber or another person placed remotely. Injuries caused to victims within the vicinity of suicidal bomber are no different from those already described above. As regards injuries to his person, his torso is extensively burnt and mutilated, occasionally only sparing partially his head and terminal portions of lower limbs. This is why in majority of cases, recoverable parts of suicidal bomber are his head and portion of lower limbs. (**Photo.7.16 & 7.17**)



Photo.7.16: Suicidal bomber torso extensively burnt and highly mutilated sparing head and partially upper limbs



Photo.7.17: Three suicidal bombers' unidentified heads recovered from different locations

Forensic autopsy of bomb blast victims is an anatomical exercise similar to sorting of skeletal remains. Determination of cause of death in most cases is obvious. Examination is guided by three principles:

- Identification of marker (trace evidence) within victim's body to know its source
- Allocation of parts to each victim to determine numbers in mutilated bodies
- Reconstruction of victim's remains to locate and recognize sites, types and distribution of injuries

Task may be simple if victim is relatively intact or it may become very difficult, even impossible, when victims' are more than one and are badly mutilated into fragments. This exercise can become extremely complicated when smaller fragments of human origin get mixed with disintegrating masonry structures or when they are not available. There are three steps of such an investigations:

- Non-human tissue, if any, should be identified and discarded
- Isolation and labeling of various parts and organs of the human origin
- Allocation of these human parts is done to the individual bodies to determine their number.

Radiology is useful and assists in identifying the trace evidence and matching of contained skeletal structures.

Forensic evaluation of wounding is necessary in every medico-legal case and also extremely important. Its proper understanding by investing police, law enforcement persons and eventual consideration by law courts for making decision is essential upon forensic medical examinations. Forensic medical certification is incomplete without this essential inference. A good example is a case of an injury:

- Self-inflicted, accidental or homicidal
- Ante-mortem or post-mortem
- Possibility of volitional activity after injury
- Duration of fatal period.

Enlisted issues are discussed one by one:

Self inflicted commonly is an abrasion, incised wound and not a bruise or laceration:

- Self-inflicted abrasion is seen on the body of a female, mostly produced by her own nails as

scratches on her face, front of shoulders and chest.

- Self inflicted bruise is difficult to produce on one's own self, being very painful process. Simulation of a bruise though can be produced by rubbing of an irritant material on the skin and can be differentiated from a true bruise. False bruise has a defined outline and tiny vesicles at its margins, which can be seen with magnifying lens.
- Self-inflicted laceration is a remote possibility unless person is very desperate or mentally ill. Only site is forehead, which is injured by striking a blunt object or banging it against wall.

Self-inflicted cuts are most common and they are multiple, arranged parallel to each other and on the accessible parts of the body such as scalp, arm, forearm and abdomen. They show tailing towards working hand and do not involve clothes. (Photos.7.18, 7.19, 7.20 & 7.21)



Photo.7.18: Healed scars of characteristic self- inflicted skin cuts on left arm/forearm and head



Photo.7.19: Multiple healed scars of characteristic self- inflicted skin cuts on abdomen of same individual with single fresh such cut on chest



Photo.7.20: Characteristic self inflicted multiple, parallel having tailing cuts on forearm of female



Photo.7.21: Characteristic self inflicted multiple and parallel cuts on forearm of male

Contrasting features of self inflicted injury and assault are listed in (Table 7.4)

Table 7.4:

Contrasting features of self inflicted incised wound with those of assault

Characteristics	Self-inflicted	Assault
Site	Accessible	Anywhere
Depth	Superficial	Usually deep
Number	Multiple	One or more
Arrangement	Parallel	Random
Tailing	Present	Absent
Clothes	Not involved	Involved
Defense wounds	Absent	Present

Elective suicidal sites with knife and firearm are different. With knife they are throat (carotid artery and trachea), chest (heart), wrist (radial artery) and upper thigh (femoral artery). With firearm they are face (forehead, temple and mouth) and chest (heart). Weapon whether knife or firearm remains clutched in hand due to cadaveric spasm.

Cutthroat features for suicide and homicide are specific.

- Suicide cutthroat comprises of one or two superficial hesitation cuts at point of initiation followed by final deep lethal wound in neck. Hesitation incisions are usually high up on left side in the right handed person and final lethal wound runs obliquely and downward. Depth is more on the side of initiation reducing towards the working hand. Carotid artery is usually spared on this side. Site in left handed person will be reversed.
- Homicidal cutthroat is boldly placed in the centre having maximum depth in the middle. Neck structures are equally cut on both sides.

Contrasting features of suicidal and homicidal cutthroat are present at neck and other body parts. (Table 7.5 and photos 7.22 & 7.23)

Table 7.5:

Contrasting features of suicidal and homicidal cut-throat

Feature	Suicidal	Homicidal
At site		
Hesitation cut	Near initiation point	Absent
Wound position in neck	High up	In the middle
Number	Usually single	More than one
Neck structures involved	Opposite side of working hand	Equally on both sides
Depth of wound	Maximum at the point of initiation	Maximum in the middle
Tailing	Present on working hand side	Absent
Others		
Cadaveric spasm	May be present	Absent
Defense wounds	Absent	May be present
Clothes staining	In front, from above downward	Consistent with body posture

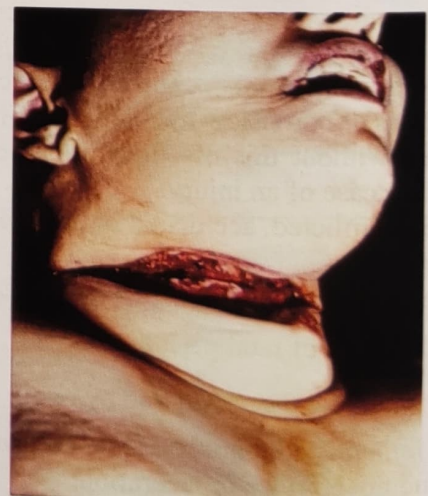


Photo.7.22: Suicidal cutthroat having more depth at point of initiation gradually reducing in depth



Photo.7.23: Homicidal cutthroat showing two bold wounds in the middle of the neck

Suicidal sites with firearm as pointed above however are front and side of face, oral cavity or blow chin and left side of the chest from close range. Suicidal wound complex shows blast effect around wound of entry staining it with smoke, gun powder, scorching entry margin and singeing of hair, if on hair bearing area. Suicidal person rarely injures through clothes and bleeding from site flows down staining cloths. (Photos 7.24, 7.25, 7.26 & 7.27)

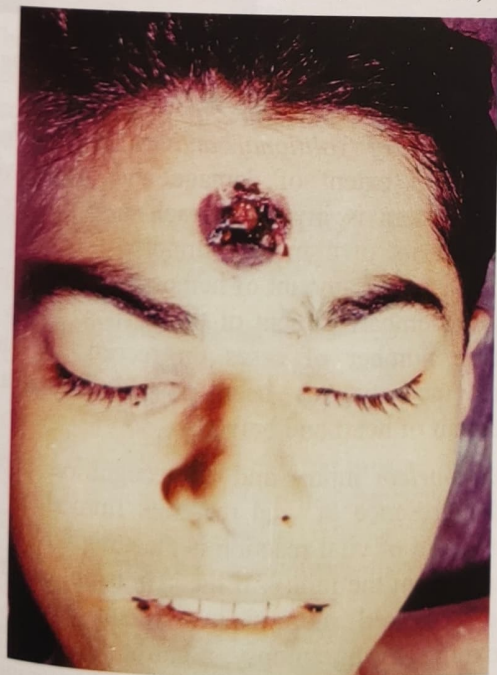


Photo: 7.24: Firearm elective suicidal site of forehead,



Photo: 7.25: Firearm elective suicidal site of temple of working hand side.



Photo: 7.26: Firearm elective suicidal site of mouth cavity



Photo: 7.27: Firearm elective suicidal site left side of chest

Firearm homicidal sites are not as clearly demarcated as those of suicidal and may be on any part of the trunk (front, side or back) usually on inaccessible parts involving internal vital organs. They are more than one and presence of two wounds strongly favors diagnosis of homicide. Covering clothes are always involved. Occasionally weapon may remain embedded and stuck in vertebral bodies in wounding of neck, chest and abdomen and acts as trace evidence. (Photos. 7.28 & 7.29)



Photo.7.28: Sharp edged pointed weapon homicidal wounds, knives embedded in neck and abdomen



Photo.7.29: Multiple sharp edged pointed weapon homicidal wounds, knives embedded in chest

Defense wound with sharp-edged weapon like knife on the body of victim is a strong indication of homicidal attack. Such wounds are present on palm and hand fingers in one line or back of forearm. They are received during an attempt to hold or ward off weapon. With blunt weapon, there may be a bruise on back or medial side of forearm. (Photo.7.30)

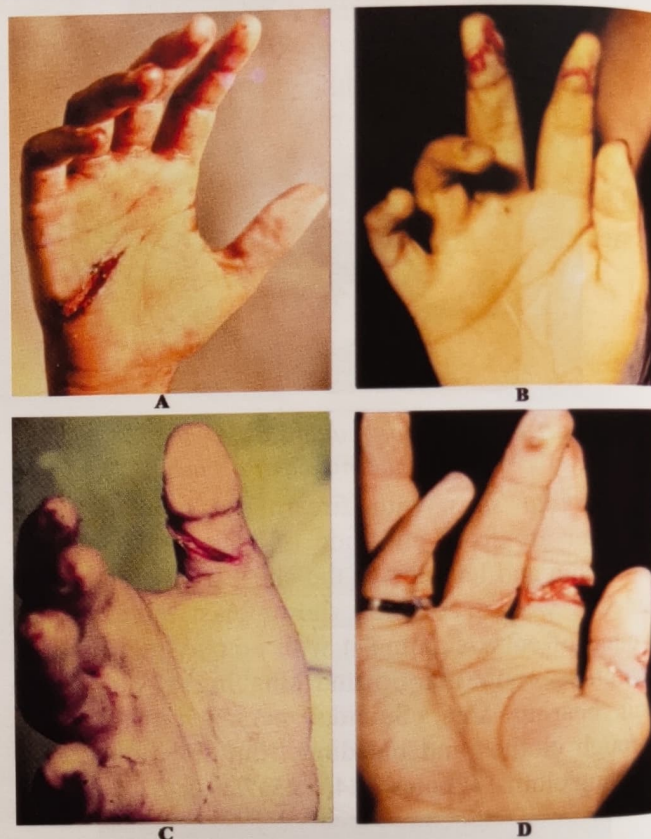


Photo.7.30: Sharp edged weapon defense wounds on hands A, palm B, C & D fingers

Possibility of volitional activity before death depends upon extent of damage and which vital organ or system is involved. Each case has to be assessed on its own merits. Important factors are speed of bleeding, amount of hemorrhage and degree of resultant embarrassment of the tissues. There are reasonable number of cases on record, in which volitional activity has been possible even after involvement of heart and brain.

Ante-mortem injury and its recognition depend upon the presence of vital reaction. Immediate and simplest form of vital reaction is bleeding within and externally from the injury. If the skin is not ruptured, the site looks red, more so in a person having fair complexion. During autopsy, a cut at site will show presence of bleeding under the skin and appearance is characteristic. In cases of flame burn, a red line of

vital reaction demarcates damaged tissue from the healthy tissue. (Photo.7.31)



Photo.7.31: Post mortem cut on back of right buttock during autopsy confirms presence of bruise under the skin

Other form of vital reaction is initiation of the process of repair. It becomes visible microscopically in about four to six hours, as invasion of white blood cells at the site of injury. With naked eye, inflammatory response becomes visible rather late. Subtle biochemical changes also take place at the site of injury, which are more reliable. Detection of these changes requires elaborate procedures.

Fatal period along with estimation of its duration is an important inference. Its determination depends upon type of involved injury, vital organ/system or blood vessel that is responsible for causing death. There are two important periods; *direct (primary)* and *soon after* and *indirect (secondary)* and *delayed* period and causes of which are discussed after (Table 7.6)

Table 7.6:

Causes of death

Direct (primary) and soon after causes

- Air embolism
- Rupture of blood vessel causing quick and extensive hemorrhage
- Mechanical injury to vital organ
- Combined effect of the latter two

Indirect (secondary) and delayed causes

- Wounds infection leading to septicemia/pyemia
- Infective processes within internal organs such as peritonitis, pleurisy, pneumonia, meningitis or brain abscess
- Subsequent necrosis with or without secondary hemorrhage
- Inter-current disease, occurring due to wound itself or by lowering resistant of the patient

Air embolism precipitates immediate death. Air may enter into circulation by intravenous infusion, laparoscopic surgery, craniotomy, urethra-scopy, fallopian tube insufflations, aortography and abortion. It can also enter through neck veins in cases of cutthroat. Factors like positive pressure in the arteries especially near the heart and negative pressure in the veins are responsible. Volume of introduced air sufficient to cause death is about 60 ml or more.

Rapid loss of blood, one third of the body is sufficient to cause immediate death in general terms. In certain specific situations especially when bleeding is within cranial and pericardial cavities, a little hemorrhage will precipitate quick death because of interference with function of these vital organs. Effusion of about 10-15 oz. of blood into the pericardial sac will prove fatal due to cardiac tamponade.

Mechanical destruction of vital organ like heart, both lungs and brain embarrasses their functions and precipitates shock, which results in immediate death.

Indirect and delayed death occurs in those cases that have non-fatal trauma. Secondary causes are therefore, results from infection involving internal organs, complication of surgery and anesthesia. Death in such victims is delayed and the period is variable depending on the mechanism of death.

Relationship of injury to precipitation of disease is an issue of any person who suffers an accidental injury or occupational disease. He can claim compensation under social security laws. The decision, whether injury or any of its complication is the outcome of an occupation may be a simple and straight forward question having this relationship already recognized and established. When the relationship of occupational disease to injury is not clear, as at times happens, it is a problematic situation. Such matter goes to the court and legal guidance on the issue is of limited character. Probability of the development of subsequent disease including neoplasm at first time site of trauma is unlikely. Trauma is a common event in life and one can easily recollect some injury to most parts of his body, when one is asked about it, especially in cases in which compensation depends upon this association. Memory tends to be encouraged even in those having moral integrity. Some of the conditions in which relationship of trauma to subsequent complications have already been established. (Table 7.7)

Table 7.7:**Trauma and related conditions**

- Infection
- Aggravation of existing condition
- Consequent conditions
- Post traumatic stress syndrome
- Neoplasm
- Occupational disease

Infection has a strong association of trauma. The most obvious example of infection going directly into the wound is an open wound caused by gunshot or other penetrating weapon. The not obvious cases are the development of meningitis and pneumonia following fracture of anterior fossa of the skull and pulmonary contusion respectively. An infected part may spread infection to other parts situated remote from the site of injury or even to the whole body. The organisms infecting uterus following a criminal abortion may cause meningitis. In such a case, it is essential not only to show that the infection followed uterine interference, but also that the infecting organism isolated in the meningitis and uterus or vagina was similar. The example of spread of infection to whole body is seen in a case of bruising of a pre-existing staphylococcal lesion in bones with subsequent development of septicemia.

Aggravation of existing injury by trauma is a common occurrence and is seen in cases of occlusion of coronary following direct injury to the artery having atheromatous disease, rupture of existing aneurysm following direct violence over it. Further the rupture of pre-existing aneurysm and precipitation of cardiac infarction with severe pain, collapse and even death due to increased demand for blood by a heart with deficient arterial supply due to coronary atherosclerosis while tightening a bolt are good examples.

Consequent conditions like **embolism**, **crush syndrome** and **bronchopneumonia** may occur following trauma to the body, more so in crushing injuries to the limbs especially when associated with bony and soft tissues like muscles and adipose tissue.

Embolism occurs either at the time of injury or during movements of injured part during transport of the patient to the hospital and is of three types:

i. **Fat embolism** occurs during surgical procedures on parts rich in fat, like breast and abdomen. Fat emboli are present in almost all cases of trauma and section of the brain and kidney stained for fat will give

confirmatory evidence. These findings are essential to establish that death is due to fat embolism.

ii. **Air embolism** occurs as a result of incised wounds involving large veins, especially cut throat. It may also occur in crush injury of chest, or as a complication of therapeutic procedures such as insufflations of the fallopian tubes. Its association with criminal abortion is well known. Opinion differs regarding length of time between the introduction of air and collapse; it is usually believed that the period has to be appreciable. Postmortem appearance is characteristic showing presence of a chain of bubbles in the neck, coronary veins and on opening the heart, its right side is filled with frothy blood. It is generally possible to trace the air bubbles to the site of entry.

iii. **Pulmonary embolism** has well-established association with injury. It occurs following development of deep vein thrombosis especially in legs from where an embolus gets detached and causes death. Injury increases viscosity of blood, makes platelets adhesive and induces venous stasis, these acts as predisposing factors for the development of thrombo-phlebitis, which develops in about two weeks following an injury.

Crush syndrome is a difficult medico-legal problem, met in cases of industrial or vehicular accidents or severe battering by police especially involving buttocks and lower limbs. It was first described during the Second World War while dealing with the victims of air raids having severe crushing of the tissue. Pigments like myohemoglobin and granular casts are seen in the tubules of kidney. This is associated with swelling and necrosis of epithelium and eventual renal failure. It was suggested that it is due to attempt on the part of kidney to excrete acid metabolites from damaged muscles. The current view negates it stating that it is due to renal ischemia and not to mechanical obstruction by casts etc. A possible combination of both conditions may be present.

Bronchopneumonia occurs in elderly people following fractures of lower limbs and consequent immobility of the patient. Shock and bad postural drainage are considered probable causes. Curling ulcer in the duodenal part of intestine occurs as a complication of burns or scalds. The mechanism is not known.

Neoplasm definitely develops at the site of repeated trauma and there is considerable medical evidence in its favor. However, its development at

the site of single injury is doubtful. Growth and repair by healing both involve laying down of new tissue. When the repair process, for any reasons becomes irrepressible, neoplastic change sets in. While entertaining its possibility, it must be remembered that the organization of the affected area takes time and when these processes become malignant further time is required. Latent period may be long.

Eying postulates are an attempt to introduce some relationship into assumption that the two events, which are chronologically related in time, may be cause and effect. These postulates do not provide scientific proof of the relationship even when these are satisfied. (Table 7.8)

Table 7.8:

Eying postulates

- Integrity of the part prior to injury
- Substantial or adequate injury to the part
- A reasonable interval of time for the development of symptoms
- Development of growth or tumor at the site of the injury
- Proof of nature of the tumor by microscopy

Assessment of the first two depends on the integrity of the witnesses who must always be tested with great care. Rest depends upon the ability of the medical examiner and on the thoroughness of medical examination.

Occupational disease especially after the application of physico-chemical trauma, which a worker suffers, is a possibility. Industrial atmosphere has noxious material and chronic exposure to toxic atmosphere produce illness by direct effect of toxic chemicals like asbestosis or indirectly by reducing

immunity and making a worker vulnerable to other diseases like tuberculosis. Criteria of relationship of trauma to occupational disease (Table 7.9)

Table 7.9:

Relationship of trauma to occupational disease

- Significant association between exposure to the agent and subsequent development of the syndrome
- Correspondence between extents of exposure and essential elements of the syndrome (some degree of dose-response relationship be demonstrable)
- Demonstration of agent or its metabolic products in the tissue
- Development of similar pathological changes in animal following exposure to similar agent (failure to obtain such changes does not negate other evidences of causation)

Koch's postulate "an agent identified in a case can be grown in successive cultures and can reproduce the disease in animals". The postulate may not be applicable as the agent may not be found in every case and it does not multiply. It may not always produce the disease or same effects in experimental animals. The effects of the agent may be modified by other factors such as the type of exposure, individual response and susceptibility. Other synergistic agents may be present in the same exposure.

Role of numerous attendant circumstances capable of influencing the appearance or manifestation of the disease initiated by the agent in question should be evolved on determination of the casual relationship based on preponderance of the evidence rather than an absolute proof.

CHAPTER 8

8. Forensic Aspect of Transportation

Modern transportation on road, rail and by air have tremendously benefited mankind with speed and comfort. But it has also been accompanied, throughout the world, with increasing traffic accidents at an alarming rate. There are now more deaths due to accidents than due to cancer. Further, those injured in such accidents are young and die at prime of age. Number of accidents is directly proportional to the number of vehicles on the road and ratio of death and injured is one death against 10 seriously and 40 slightly injured. West Germany having same population as U.K., total deaths is much more because of more vehicles. In Pakistan correct statistics is not available, but it is felt that number of dead and injured per mile traveled is much more than many other countries. (Table 8.1)

Table 8.1:

Ratio of number of deaths and injured of road accidents

Country	Deaths	Injured
USA	40,000	2,000,000
U.K.	7,000	350,000
West Germany*	17,000	850,000

* More vehicles

Traffic accidents have been investigated from point of view of mode of travels i.e. road, rail and air. Road accidents are on the top with much higher in number comparing with other modes, thus more important. Motorized vehicular accidents involve both pedestrians and occupants. Victims of impact accidents are mostly occupants. Crash accidents produce damage to both pedestrians as well as occupants. Two-wheeler is unstable and unprotected and is responsible for major share in causing injuries to the victims, who are mostly pedestrians sparing vehicle occupants. Another basis

of investigation is type of accidents. As regard accident causation including determination of motive, driver's health and intoxication are of paramount importance especially with single vehicle. (Tables 8.2, 8.3 & chart 8.1)

Table 8.2:

Road-traffic accident causation

Mechanical factor

Faulty engine (carbon monoxide poisoning),
Mechanical failures (breaking of tie-rod or burst of tyre)

Environmental factor

Poor visibility
Traffic density versus speed of vehicle
Audio-visual distractions

Personal factor (driver)*

Physical disability (loss of vision, hearing or limbs)
Psychological disability (depression, mania, schizophrenia)
Acute episode of pathological condition (coronary disease, epilepsy)
Spontaneous illness (renal colic)
Systemic disease (hypertension, renal disease, diabetes)
Drugs (alcohol, tranquilizers, amphetamines)
Fatigue (precipitates mental block and power of decision)

* More important for medical certification.

Table 8.3:

Type of road-traffic accidents

• **Number of vehicles involved**

Single or more vehicles

• **Direction of the impact**

Frontal, lateral and rear impact

• **Motive of accident**

Crash with motive (homicide, suicide or to mask accident) or without motive (due to intoxication)

• **Extent of damage to injured**

Minor (injuries trivial, victim not hospitalized)

Moderate (injuries serious, victim hospitalized for a week)

Severe (injuries endanger life, victim hospitalized for more than a week)

Fatal (victim either dies on the spot or within 30 days of hospitalization)

ROAD TRAFFIC ACCIDENT			
NUMBER OF VEHICLES	DIRECTION OF IMPACT	EXTENT OF VICTIM'S DAMAGE	MOTIVE DETERMINATION
Single More (mass accident)	Frontal	Minor	Crash without motive (Intoxication) Crash with motive ├─ Homicide ├─ Suicide └─ Mask accident
	Rear	Moderate	
	Lateral	Severe Fatal	

Chart 8.1: Classification of road traffic accident

Victims of traffic accident are knocked down pedestrians, pedal cycle rider, vehicle seated passengers including driver and un-seated occupants of public transport. In case of mechanized road and rail transportation, victims are both pedestrians and occupants whereas in the case of travel by air victims are occupants only. Injuries on the body of the victims are generally consistent with circumstances of accident, type of vehicle and seating arrangements of occupants. Mode of transportation such as road, rail or air also modifies type of injuries.

Distribution of transportation accidents injuries is divided into two groups

depending upon causation i.e. impact and acceleration/deceleration mechanism. Impact injuries to pedestrians occur at sites of impact involving external surfaces of the body and their distribution depends upon whether impact is **primary, secondary or tertiary**.

Primary impact injuries are situated on legs, thighs or hips, *secondary impact* on back of body, face/fore-head and top and *tertiary impact* may occur during dragging/run-over and burning of vehicle, which only occurs if vehicle catches fire. (Fig. 8.1)

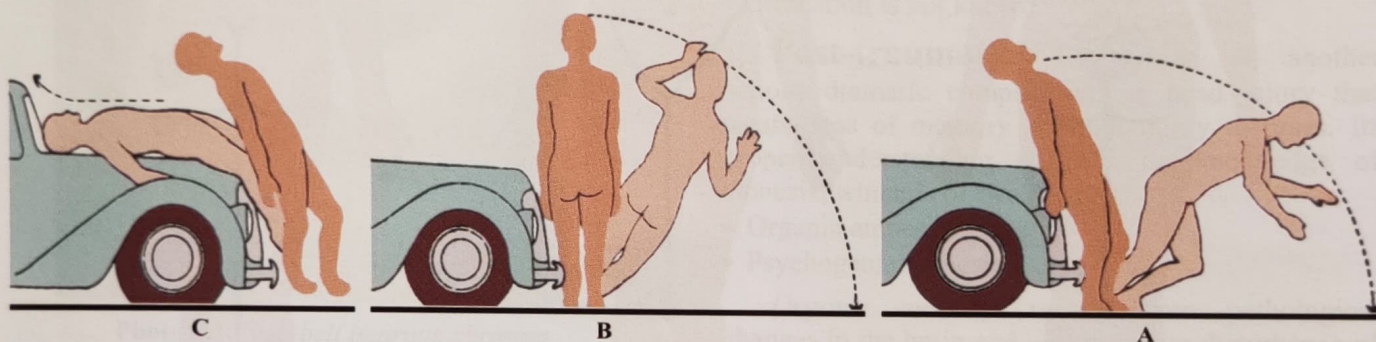


Fig 8.1: Primary impact sites on external surface to victim's body by bumper A & B at back/left side of leg with feet fixed on ground. C. Secondary impact sites at back of trunk with feet sliding from ground.

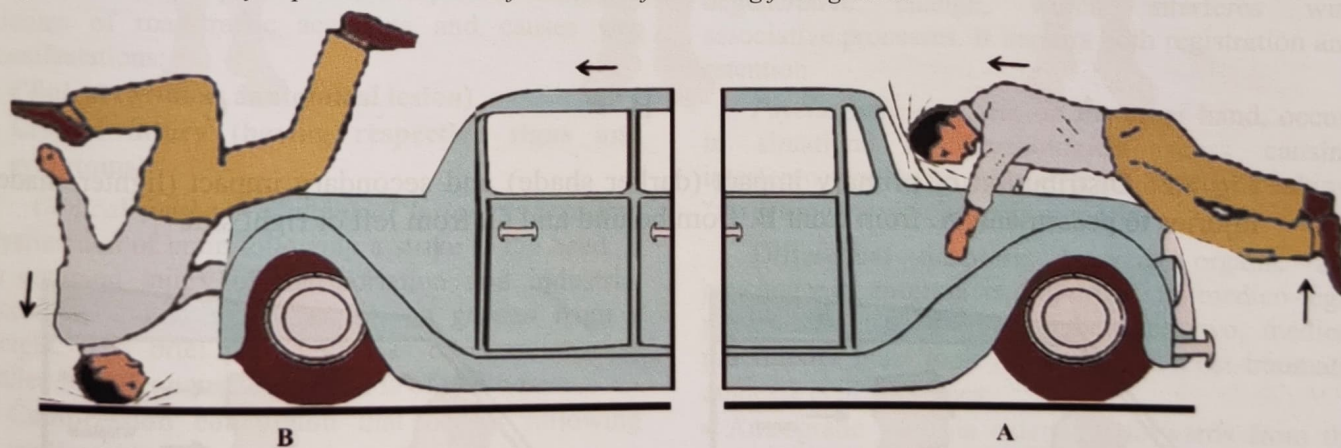


Fig 8.1: Victim lifted and sliding over the vehicle finally head hitting ground. A. Secondary impact site on head hitting bonnet/windscreen with feet lifted from ground B. tertiary impact site at head after rolling over vehicle and finally hitting ground

Acceleration/deceleration injuries occur to occupants of vehicle involving internal organs of body cavities mainly head and chest while it is accelerated or de-accelerated. There are three mechanisms:

- Frontal impact of vehicle against an object causes deceleration of vehicle and common parts of body

of front seat occupant including driver get injured are scalp, face, chin, chest, hip, knees and legs

- Rare impact produces acceleration of vehicle already running vehicle and injuries generally occur to neck, lumbar and hip regions.
- Lateral impact is at middle part of the vehicle and injuries are always crash type.

Besides, there are injuries due to structures that are fitted inside the vehicle. These structures are seat belts, steering assembly, instrument panel, dashboard,

windscreen, backrest and door handles. (Fig. 8.2 & 8.3)

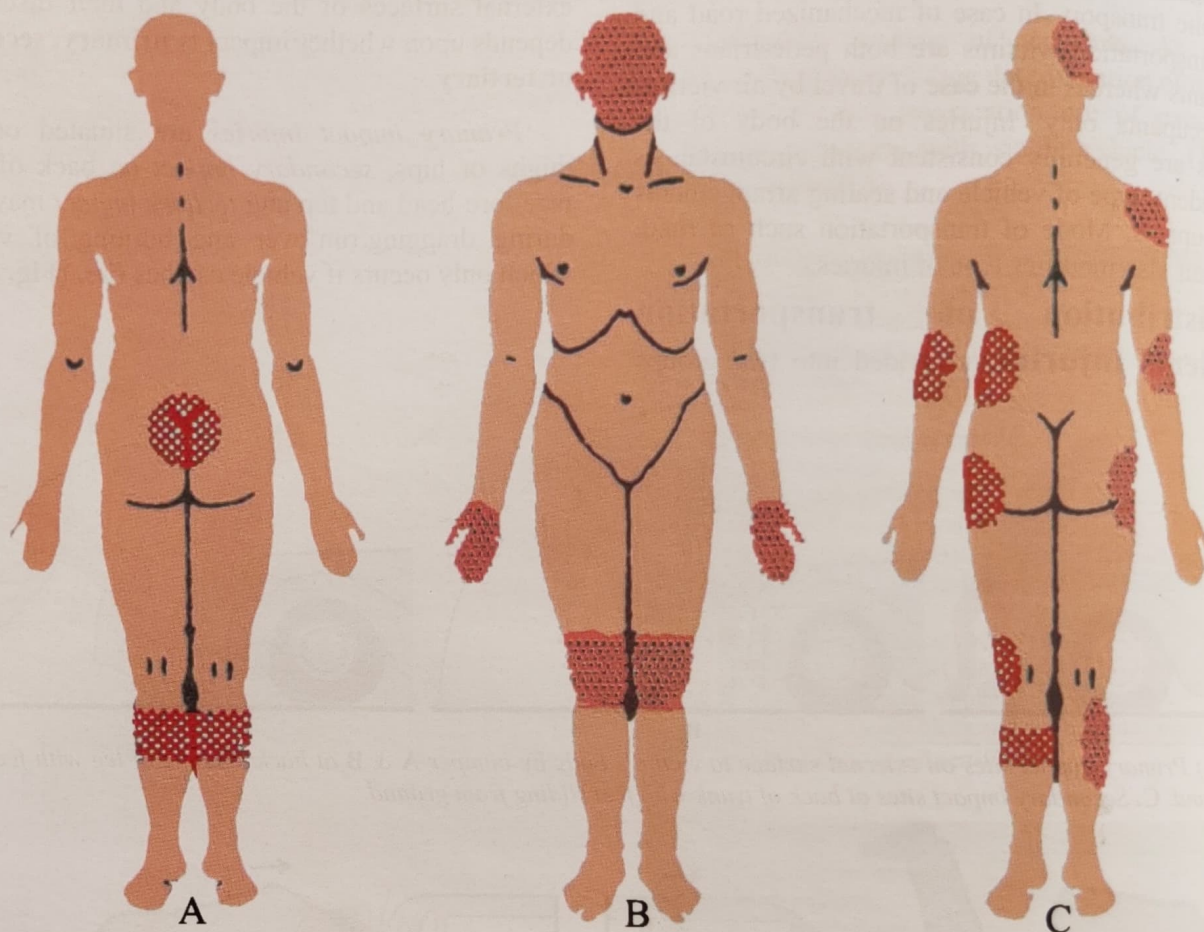


Fig 8.2: Distribution of primary impact (darker shade) and secondary impact (lighter shade) injuries to pedestrians. **A.** from front **B.** from behind and **C.** from left or right side

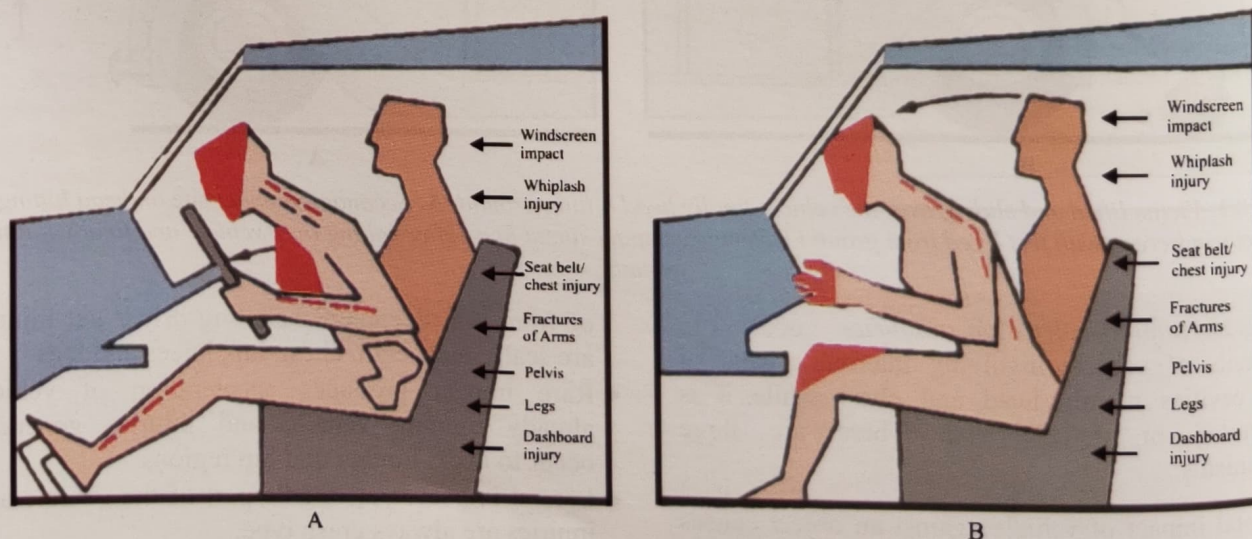


Fig 8.3: Impact injuries to front seat occupants, **A.** driver **B.** other

Besides above stated injuries, during accident there are other injuries. A characteristic chest injury to driver is an imprint abrasion caused by seat belt. If door of vehicle gets opened and occupant thrown out suffers from tertiary injuries, which are due to ejection, striking against road, dragging or run-over by other vehicle and in case of fire burn injuries. (Photo.8.1)



Photo 8.1: Seat belt imprints abrasion

Head Injury is the most important trauma to victims of road-traffic accidents and causes two manifestations:

- **Clinical (without anatomical lesion)**
- **Cranial injury (having respective signs and symptoms)**

Clinical (without anatomical lesion) is transient dysfunction of brain following a strike to the head. It is common injury of transportation and industrial accidents and even due to fall on ground from a height. It is brief period of loss of consciousness called **brain concussion**, which is of two types:

- **Compression concussion** that occurs following application of force to stationary head
- **Acceleration concussion** which is caused by the application of force to head in motion

Acceleration concussion is severer of the two. It is said to result from jerky movement of the brain substance in the hard cranial cavity. **Post-concussive syndrome** may occur in some cases after recovery of consciousness. Symptom-complex of this syndrome is nervousness, headache and dizziness. Residual symptoms may get prolonged in compensation cases after head injury. It is difficult to ascertain that a given train of symptoms is true post-concussive

manifestation. Many are of the view that *post-traumatic neurosis* is a separate entity and it should be differentiated from post-concussive syndrome. Post-traumatic neuroses like hysteria, anxiety and terror neurosis have now been replaced with a broader diagnosis of *post-traumatic stress syndrome*. Careful study of related factors, which include psychological and economical aspects of injury, will disclose the true picture. There are no positive findings in EEG and autopsy except a few petechaeal hemorrhages in brain substance along with disintegration of brain cells having some alteration in the nucleus and that too in very few cases. Its signification is not known.

Post-traumatic amnesia is another serious dramatic complication of head injury that means loss of memory after an injury to brain. Its proper understanding depends on knowledge of amnesia, which is of two types:

- Organic amnesia
- Psychogenic amnesia

Organic amnesia results from pathological changes in the brain and occurs due to disturbance of neurons through chemical alteration, trauma or degenerative change, which interferes with associative processes. It impairs both registration and retention.

Psychogenic amnesia, on the other hand, occurs in situations of psychological stress causing interference in the process of recall. Strictly speaking, "forgetting" is psychogenic amnesia.

Differential diagnosis between organic and psychogenic amnesia is important in medico-legal practice and to differentiate between two, medical practitioner must look for the cause. Post-traumatic amnesia is of two types:

- **Antrograde amnesia** extending forwards from the time of injury
- **Retrograde amnesia** extending backwards from the time of regaining of consciousness.

In cases of severe injury to the head, there may be retrograde amnesia showing loss of memory extending backward over a period, which is accompanied by loss of consciousness. It may also follow in many other forms of organic interference with cerebral function like an epileptic fit. Recovery from this type of amnesia does occur and recall is chronological, those memories nearest to injury being last to recover. Retrograde amnesia may also be

psychogenic in origin and has been known to stretch back over a long period.

Behavior of the victim before and after an incidence is important evidence in deciding responsibility. In offenses associated with epilepsy, there is often no attempt at concealment, if there has been true amnesia. An attempt by the offender to run or conceal the act suggests knowledge of what he has done. Amnesia for the crime is usual complaint and forgetting the act of crime does not affect responsibility.

Cranial injury occurs in both traffic and industry accidents especially to the mobile head. Various types are bruising/laceration of scalp, fracture of skull bones cerebral contusion/rapture of brain matter and intracranial hemorrhages to head. Gross crushing of head is characteristic of run-over accidents precipitating sudden death. (Photo 8.2 & 8.3)



Photo.8.2: Re-placed top portions of crushed head following run-over accident



Photo.8.3: Gross skull fracture, rapture of covering, displaced out brain and massive hemorrhage

Mechanism of causation of head injuries to mobile head is acceleration/deceleration of the brain. Resultant injuries are:

- Coup

- contre-coup

Effects on the brain are immediate because of direct consequence of trauma. Site of coup injury certifies point at which accelerating or decelerating force has been applied. Greater the forces, severer are the injuries. Lesion may not be symmetrical and many varieties of lesions within the cranium are produced because of many partitions of cranial cavity. While interpreting cerebral injuries, a word of caution that multiple mechanisms produce complex picture and one may find lesions in brain, which cannot be explained by a single mechanism. What is important that sites of intra-cranial hemorrhage and their relationship with clinical signs and symptoms is properly understood. Important sites of intra-cranial hemorrhages are:

- Extradural hemorrhage
- Subdural hemorrhage
- Subarachnoid hemorrhage
- Intra-cerebral hemorrhages

Extradural hemorrhage in adults is exclusively traumatic. However, extravasations may occur due to blood dyscrasias in infants. A depressed fracture over a sinus, or a linear fracture across line of the meningeal artery or vein ruptures them causing hemorrhage. The most common site of extradural hemorrhage is temporal fossa due to the rupture of middle meningeal vessels. Posterior fossa hemorrhage may not be immediately fatal, in these cases, chronic hematoma is often seen at autopsy and they are not encapsulated. (Photo.8.4)

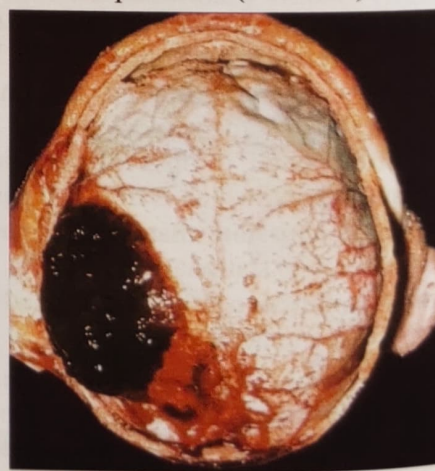


Photo.8.4: Extradural hemorrhage over left temporal

Subdural hemorrhage is also traumatic in origin, though it may occur due to effusion of blood into the subdural space following rupture of an existing aneurysm in the cerebral blood vessels. Primary type

is due to a laceration in superior cerebral vein at the point of contre-coup. Accumulation of blood occurs over the upper part of dorsolateral surface of the cerebral hemisphere, which flattens convolutions of the opposite side with distortion and dislocation of the ventricle. In acute cases, symptoms of compression manifest in about 24-48 hours. Typical symptom complex is lethargy increasing to stupor and coma, unless this lesion is treated surgically. There may be slowing of pulse, dilatation of pupils and development of unilateral motor manifestations accompanied with high temperature. The patient may develop labored respiration, sweating and rapid pulse before dying. When recovery does not occur following surgical evacuation of the subdural clot, such patient remains in vegetative state for weeks before death. Softening of dorsolateral cortex by direct pressure of hematoma may take place, which is seen during autopsy.

Latent form of subdural hemorrhage develops due to slow leakage from a perforating vein. No symptom of this mishap appears. Subdural space has no meso-thelial lining and thus can do very little to resolve it. Subdural hematoma eventually becomes a blood cyst, which remains so for months or even years. The hematoma becomes encapsulated and the covering membrane gradually thickens. The secondary type occurs in association with gross contusion of frontal and temporal lobes with blood seeping through the covering into the subdural space. They are usually located over the injury. (Photo 8.5)



Photo 8.5: Subdural hemorrhage over right temporal

Subarachnoid hemorrhage may be traumatic in origin or may occur otherwise. Traumatic hemorrhage occurs in a considerable percentage of patients suffering from cranial injuries who remain unconscious for more than three hours. Primary type occurs in patchy distribution and is of mild degree

over parietal and occipital region of one or both sides or about posterior margin of the cerebellum. Other variety other than traumatic subarachnoid hemorrhage may also occur due to a rupture of an aneurysm usually at the base of the skull. In very severe injuries, the entire subarachnoid space may be filled with hemorrhage. Secondary type occurs in the immediate neighborhood of the contusion or lacerations of brain. Traumatic subarachnoid hemorrhage seldom plays a part in fatal issues and is just a contributory factor to other causes. (Photo 8.6)



Photo 8.6: Subarachnoid hemorrhage

Intra-cerebral hemorrhages are sustained in traffic accidents, falls from height or in industry. They are the results of coup/contre-coup mechanism. A high percentage occurs in fatal head injury cases.

i) Primary variety is the direct result of injury and found in the central part of frontal or temporal lobe. The frontal lobe effusions extend upwards and laterally whereas the temporal effusion is in the middle portion extending into the occipital lobe. The hemorrhage dissects its way along the fiber bundles. A larger effusion may rupture into a ventricle when death usually follows. The clinical course of this type of hemorrhage is slow manifestation in a variable interval after the injury. If the interval is more, it is called *delayed traumatic apoplexy*. After a posttraumatic interval of days or even weeks, a hemorrhage effusion may be found in the substance of brain. Any interval longer than three weeks suggests a spontaneous rather than delayed traumatic hemorrhage.

ii) Secondary type is a complication of severe contusion of the brain substance. A clot of considerable size may be found in the brain substance beneath the superficial lesion. Death usually occurs due to severe degree of cerebral edema, cerebral contusion and associated hemorrhage. The traumatic

intra-cerebral hemorrhage should be clinically differentiated from spontaneous apoplexy. The distinction is not so simple. In the case of traumatic variety, the interval between the injury and the onset of symptoms is usually a week. Injury to the head must be sustained while the head is in motion. Location of post-traumatic hemorrhage is usually in white matter of frontal and temporal regions. Occasionally it may be in the occipital region and post-traumatic hemorrhage is more common in young healthy individuals. Spontaneous hemorrhage is usually in the ganglion regions in a patient who is overweight and has a history of high blood pressure prior to the onset of stroke. The most common etiological condition associated with this type of hemorrhage is aneurysm of the intracranial arteries. There may also be evidence of degenerative arterial disease either clinically or at postmortem examination, particularly at the margin of the hemorrhage. Usually there is no difficulty in distinguishing between the two types during postmortem examination. (Photo 8.7)

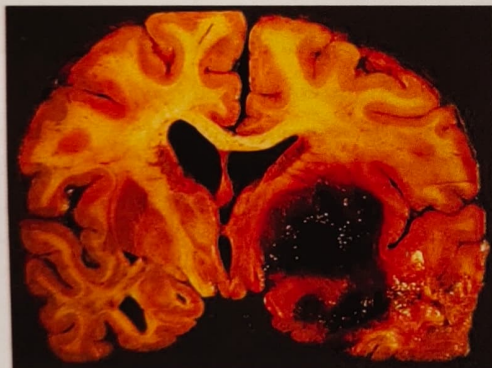


Photo 8.7: Intra-cerebral hemorrhages

Road traffic accident investigation is a teamwork calling entire spectrum of expertise, especially in mass accidents. Team generally comprises of three experts:

- Medical Examiner
- Vehicles Examiner
- Forensic Science Expert

Medical aspect of investigation is the responsibility of Forensic Medical Examiner, who is generally asked to act as team leader. He may have to be assisted by other specialist like pathologist, toxicologist, serologist and odontologist, (wherever necessary) for preparation of report about identity of driver and other victims. Vehicle Examiner is there to examine vehicle/vehicles in case of mass accident and prepare report about their conditions. Scrutiny,

sketching, photographing and collection of evidence from scene fall within the domain of Forensic Science Expert. Role of police at the scene of accident is exclusively to protect it from public interference.

Investigations differ when accident is by **single vehicle** and **mass vehicles**:

- *Single vehicle accident* requirements is careful transportation of injured victim/victims, dead body/bodies from scene of accident to hospital and autopsy room and non-biological material to forensic laboratory taking precaution not to lose any trace evidence during transit. Medical examination in hospital/autopsy room includes examination of clothes and persons of the victims like other medico-legal examinations.
- *Mass vehicles accident* requirement is guided by numbers of bodies of victims and types of injuries on them. It requires elaborate arrangements at site, which are nearly always improvised. A temporary secretariat is established for incoming information, which facilitates the job. Area should be sealed off by police to protect and preserve property of the victims from unauthorized intruders.

Establishment of personal identity of each victim including that of driver/pilot is important and performed in two stages; preliminary at scene and subsequent detailed examination of injured in hospital and dead persons in autopsy room. Objective of both medical examinations is same.

Clothing of victims is examined for damage and fresh contamination with foreign fragments such as glass, paint or any other thing in them. Special attention should be paid to peculiar characteristics such as tyre and grit marks, any other foreign smears on the skin or foreign material in the wounds, distance of injuries from heel and direction in relation to body planes. Careful efforts should be made to recognize specific injuries and their distribution to consistent with history of accident. Attempts should also be made to establish direction of impact. Study of motive of accident being accident, suicide, homicide should be done to determine any mask mechanism. Determination of mode and cause of death with role played by a disease or intoxication especially in the car driver or aircraft pilot will establish human cause of accident.

Identification of the driver is a pre-requisite to know human cause of accident. There is normally no problem in identification of driver in case of road and

rail transportation but in case of aircraft accident, personal identity of the pilot may be extremely difficult because of severe degree of burns caused by conflagration. In many cases, even the assessment of number of victims is a difficult task. Prior existence and availability of accurate passengers' information helps the job and its absence is notable complication to the determination of personal identity of victims.

Principle used for the personal identity of the victims is that initially all identifiable bodies should be separated, numbered and accurately plotted as to the position of their discovery before they are removed from the scene. It is followed by collection of mutilated human parts to reconstruct bodies by matching of the parts. Disassociated effects should also be numbered and mapped. Objective parameters of personal identity such as possessions, clothing, human body parts or of those having specific pathology or dentition should be transported to the laboratory for further examination such as X-ray and microscopy. Objects removed in the mortuary from the body should be placed in already numbered containers.

It is established beyond doubt that personal factor is the major cause of accidents. As regards mechanical and environmental factors, they play comparatively little role. Fitness of road vehicle driver is of paramount importance. Safety on road with so many speeding vehicles and many pedestrians at the same time imposes great responsibility on the driver to be fit before taking charge of his vehicle. Eligibility of driver to possess a driving license depends upon two things:

- Skill of driving of vehicle
- Physical/mental fitness to perform driving.

Both above criteria are legally laid for issue of driving license in all countries including Pakistan.

Motor Vehicle Ordinance 1965 has prescribed conditions for issuing of a driving license. Additionally it prohibits issuing of driving license to persons suffering from certain diseases or disabilities, which are enlisted in schedule. For this purpose, besides other conditions, the most important one is medical fitness certificate to be filled by registered medical practitioner. (Table 8.4 & Fig 8.5)

Table 8.4:

Laid conditions for issue of driving license

- 1) Prescribed application form
- 2) Prescribed medical certificate of fitness from RMP *
- 3) Applicant age, 18 years for private and 21 year as paid employed
- 4) Skill of driving (to be tested) by licensing authority

*Special attention to distant vision and condition of arms, hands and joints of both extremities

MEDICAL CERTIFICATE OF FITNESS TO DRIVE A VEHICLE	
(To be filled up by a registered medical practitioner)*	
1. What is the applicant's apparent age?.....	
2. Is the applicant subject to epilepsy, vertigo or any mental ailment likely to affect his efficiency?.....	
3. Does the applicant suffer from any heart or lung disorder which might interfere with the performance of his duties as a driver?	
4. (a) Is there any defect of vision? If so, has it been corrected by suitable Spectacles?	
(b) Can the applicant readily distinguish the pigmentary colors red and green?	
(c) Does the applicant suffer from night blindness?	
(d) Does the applicant suffer from a degree of deafness which would prevent his hearing ordinary sound signals?	
5. Has the applicant any deformity or loss of member which would interfere with the efficient performance of his duties as a driver?	
6. Does he show any evidence of being addicted to the excessive use of alcohol, tobacco or drugs?	
7. Is he generally fit as regards (a) bodily health,.....	
(b) eyesight?	
5. Marks of identification: (i).....	
(ii).....	
I certify that to the best of my knowledge and belief the applicant is the person herein above described and that the attached photograph to a reasonably correct likeness of the applicant	
Space for Photographs	Signature
	Name
	Designation.....

Fig 8.5: Prescribed specimen of medical certificate

Issue of inheritance, whenever all family members die in an accident, is important. Medical findings in such cases remain inconclusive and it has to be resolved on the basis of the presumption of law of survivorship at the time of death of each victim. Presumption of law of survivorship is that:

- Younger in age shall survive the older
- Male shall survive the female
- Healthy shall survive the diseased

CHAPTER

9

9. Sexual intercourse, related issues

Sexual intercourse between husband and wife in natural way after marriage is legally permitted and also biological necessity for procreation. On the other hand sexual intercourse between man and woman, who are not validly married, is illegal. Inability to perform sexual intercourse by either party due to any reason raises the question of dissolution of marriage. Issues, which are generally raised during the course of functioning marriage, are **potency, virility** and **fertility** of couple. Potency and virility relates to male mainly for man's quality that is associated with his overall health, sexual vigor and sturdiness for fathering of child and fertility is generally for female's ability to conceive. They may exist singly or co-exist together overlapping one with the other.

Potency is attained by both sexes at puberty and law presumes its presence above this age and absence below this age. Law further presumes that after attainment of puberty man is capable of begetting and woman bearing children. Proof of potency is largely inferential. A boy below this age has power of erection and ability of coitus and similarly girl's ovulation and menstruation may commence before age of puberty and she becomes sexually developed even at an earlier age.

Impotence is inability of either spouse to perform sexual intercourse and may occur because of **physical** or **psychological** causes giving rise either to temporary or permanent incapacitation. Permanent impotence from physical causes is important and very serious question to consummate marriage. When such condition is brought to the notice of court, it declares marriage null. It is also raised in cases of disputed paternity, zina and claims for damages for loss of sexual function due to criminal or accidental injury at work. (Table 9.1)

Psychological impotence may occur due to fear of inability to proper sexual intercourse, disgust of act and dislike for partner. Underlying concepts result in non-erection and prevention of coitus in males. In females, it is of an active nature leading to spasm of vagina, which precludes intercourse. There is reflex spasm of levator-ani and perennial muscles, adductors of thighs and erector spinae. This condition is known as **vaginismus**. Perennial anatomy though is

normal, yet fear of act or dislike of partner is the cause.

Table 9.1:

Physical causes of impotence

Local

Male Congenital or acquired absence of sex organs, cancer of penis, sarcoma of testis, large hernias, hydrocele and elephantiasis

Female Congenital absence or atresia of the vagina, firm or imperforate hymen, adhesions of labia prolapsed uterus, vaginal tumors

General Both sexes

Diseases of central nervous system such as hemiplegia, disseminated sclerosis, syringomyelia
Endocrine dysfunction of pituitary/thyroid gland
Abuse of drugs (alcohol/other drugs of addiction)
Obesity*

* In male only and not in female, as her role is entirely passive.

Sterility between marriage partners and **pregnancy** of fertile female are two important conditions affecting a functioning marriage. Both conditions though are not taken to court of law during a trail of dissolution of marriage, yet have forensic issues.

Sterility is inability of male to impregnate and female to conceive and causes of sterility are either congenital non-production of germ cells i.e. spermatozoa in male and ova in the female or other causes in male are malformations of penis such as hypospadias, epispadias, surgical removal of testis, contraceptive operations and infections like gonorrhea and in females are infections of reproduction apparatus, uterine displacement, diseases in ovaries and lesions in tubes.

Pregnancy is consequential corollary in fertile female having forensic issues like abortion affect both marriage partner and other members of family emotionally. Whenever related issue is brought to the court of law, medical examination of female, product of conception/fetus becomes essential.

During the course of pregnancy starting from its onset to the stage of delivery, if anything adversely happens and its progress or developing child suffer, is viewed suspiciously of foul play. It is for this reason that the topic of pregnancy is divided into many subtitles like **age of conception, proof of pregnancy, duration of gestation, proof of delivery, twin pregnancy, abortion and newborn baby.**

Age of conception is a specific age, which begins when she attains age of thirteen years and goes up to uppermost age of forty five years. Courts have accepted possibility of conception even at lower age of twelve-year and upper age of fifty years as uppermost limit.

Proof of pregnancy depends upon subjective history by female and objective findings observed during medical examination. Common indications of pregnancy are amenorrhea and enlargement of abdomen, which has to be differentiated from other such conditions. (Table 9.2 & 9.3)

Table 9.2:**Chronological indications of pregnancy****Clinical symptoms (by patient)**

- Amenorrhea
- Morning sickness (nausea and vomiting)
- Frequency of urination (irritable bladder)
- Perception of:
 - (i) Fetal heart sounds
 - (ii) Fetal movements

Signs in breasts

- Size enlargement
- Darkening of nipples and areola (due to pigmentation)
- Enlargement of Montgomery's tubercles

Signs in abdomen

- Gradual enlargement (till full term)
- Skin pigmentation (from pubis to umbilicus)
- Appearance of stria-gravidarum

Signs in the vagina

- Increase in secretions
- Darkening of mucosa
- Gradual softening of cervix uteri

Investigation findings

- Detection of:
 - (i) Gonadotropic hormone in the urine
 - (ii) Gestation sac on ultra-sono-graphy
 - (iii) Fetal bones on X-ray

Table 9.3:**Differential diagnosis of pregnancy**

- Pathological secondary amenorrhea
- Fibroid uteri
- Ovarian cysts
- Retention of urine and constipation
- Abdominal obesity
- Menopause
- Pseudo pregnancy

Duration of gestation is ten lunar months (forty weeks or two hundreds eighty days). Extension in this period is possible because day of ovulation may be between tenth to fifteen day after cessation of last menstruation, thus total number of days would be two

hundred eighty plus ten or fifteen days. Further, day of coitus may not be day of conception as viability of sperm after ejaculation established after post-coital tests of smears from vagina varies from two hours to two days, if it is high up in the uterus. Further pre-maturity or post-maturity may reduce or prolong duration of gestation. Courts have accepted maximum duration of gestation up-to three hundred and forty five days.

Twin pregnancies include identical and fraternal twins, which is normal phenomenon. Other possibilities of twin pregnancies are more important from medico-legal point of view and they are defined below:

Super-fetation means fertilization of two ova, each of which has been liberated at different ovulation. There is sufficient medical evidence that it exists but law does not entertain this possibility.

Super-fecundation refers to fertilization of two ova, both liberated during same period of ovulation, but impregnated as a result of two separate acts of coitus.

Proof of delivery will depend upon signs of full term pregnancy modified by event of delivery whether **recent** or **remote**.

Signs of recent event are that abdomen is lax, uterus is palpable as a hard globe about five inches above pubis. It sinks behind pubis about the tenth day. Other findings include injuries to birth canal in the form of tears of vagina and a specific vaginal discharge called *lochia*. This discharge is blood stained for first four days or so, then becomes offensive and white in color and disappears around the tenth day. Additional finding, during autopsy is presence of corpus luteum in non-pregnant woman up-to ten days after its formation and in pregnant up-to the fifth gestational month. Inner wall of the uterus shows signs of detachment of placenta. Size of the uterus has a relation to stage of pregnancy. (Table 9.4)

Table 9.4:**Relationship of uterine size to stage of pregnancy**

Month of gestation	Size of the uterus
3	4-5 inches
4	5-6 inches
5	6-7 inches
6	8-9 inches
7	10-11 inches
8	11-12 inches
9	12-14 inches

Signs of remote event depend upon time duration and loose importance due to gradual modification/disappearance of signs of recent event.

Abortion in the life of female is a sad event having immense impotence because of causing injuries and death of both fetus and mother. It is induced at various stages of pregnancy either by skilled and authorized medical practitioners, which is necessary to save life of mother or unqualified and unauthorized abortionist. Therapeutic techniques include:

- Dilatation and curettage—(unto twelve weeks)
- Hysterotomy—(abdominal or vaginal) after twelve weeks
- Amniocentesis—(abdominal or vaginal) later stages
- Vacuum suction—(later stages)

Criminal interference should be detected and distinguished from *therapeutic technique* used. No statistics are available and it is believed that twenty percent of all pregnancies end prematurely and forty percent of them are due to criminal interference.

Methods of criminal interference vary with duration of pregnancy dependent upon three stages of pregnancy. (Table 9.5)

Table 9.5:

Stage of criminal termination of pregnancy

Stage	duration	Methods
Ovum	Ten days	Violence (direct)
Embryo	Ninth week	Poisonous drug
Fetal	Till delivery	Instrumentation

During first ovum stage, woman being not sure about her pregnancy, resorts to severe exercise, hot water baths and vaginal douches with the hope that they will cause abortion. In second embryo stage, suspicion of pregnancy becomes a certainty and all criminal abortions take place in first three months during this stage. Poisonous substances are chosen for ingestion. No drug is safe and a drug, which can kill fetus, may also kill mother. Drugs commonly chosen include which:

- Cause reflex irritation of uterus such as purgatives and essential oils
- Act directly on uterus like ergot
- Have specific action as posterior pituitary extract and quinine. (Table 9.6)

Table 9.6:

Abortifacient drugs list

Acting indirectly on the Uterus

Emetics	Tartar
Drastic purgatives like apiol, juniper	Castor and croton oils, essential oils and turpentine
Local Irritants	Salts of heavy metals like oleate of lead

Acting directly on the uterus

Ecbolics	Ergot, gossypicum, pituitary extract, quinine,
Amniogauges	Synthetic estrogens, borax, oil of savin

In third fetal stage, in view of failure of earlier methods, drastic measures are adapted. All kinds of probing instruments such as pencils, knitting needles, nails are passed into the vagina with the hope to dislodge the fetus. *Higginson's syringe* loaded with disinfectant like dettol or even concentrated soap water in poisonous concentration has been used in an attempt to detach the placenta. Such attempts, on many occasions, cause death of the mother. (Fig 9.2)

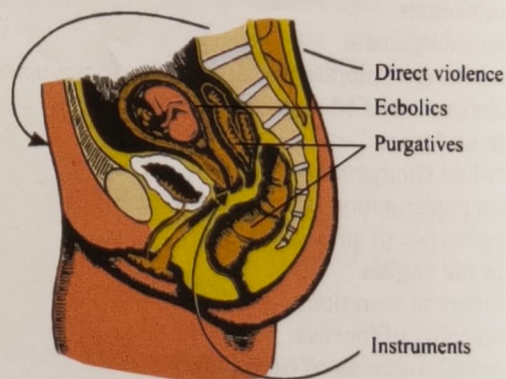


Fig 9.2: Methods of criminal abortion

Death of pregnant woman due to criminal interference is either rapid or delayed death.

Rapid death gets precipitated because of vagal shock, air embolism or quick and massive hemorrhage.

- Death from vagal shock occurs in sensitive pregnant woman, who is subjected to criminal interference without anesthesia. Application of stimulus to neck of the womb is like one applied to larynx or trachea. It is capable of precipitating vagal inhibition and sudden arrest of heart. Death occurs almost instantaneous. If woman attempted self-abortion, she would be found dead amongst apparatus and when attempted by unqualified abortionist, who will vanish from scene on women's death. Women dying of vagal shock show no internal and external hemorrhage, but

only indicators confirming interference. (Photo 9.2)



Photo 9.2: Vaginal shock death of victim women. No hemorrhage, small intestine suspecting as umbilical cord pulled out and tied. Many bruises on upper and medial part of thighs conforming interference

- ii. Death from air embolism results from air being pumped into cavity of the womb, during an intrauterine injection. Stripping of membrane from uterine wall and detachment of the placenta expose large blood vessels and negative pressure in veins may suck sufficient air and other fluid into the circulation. Air is carried to heart via inferior vena cava and then to the pulmonary circulation leading to rapid death.
- iii. Death from rapid hemorrhage is because of two possibilities. Firstly, hemorrhage may get collected into the uterine cavity due to rupture of a large blood vessel following detachment of the placenta. In other situation, curate may perforate uterus and injure uterine vessels or following perforation may go into the abdominal cavity cause injury to intestines. In such cases large volume of blood is either retained in non-contracting uterus or abdominal cavity and there is very little external hemorrhage. (Fig 9.3)

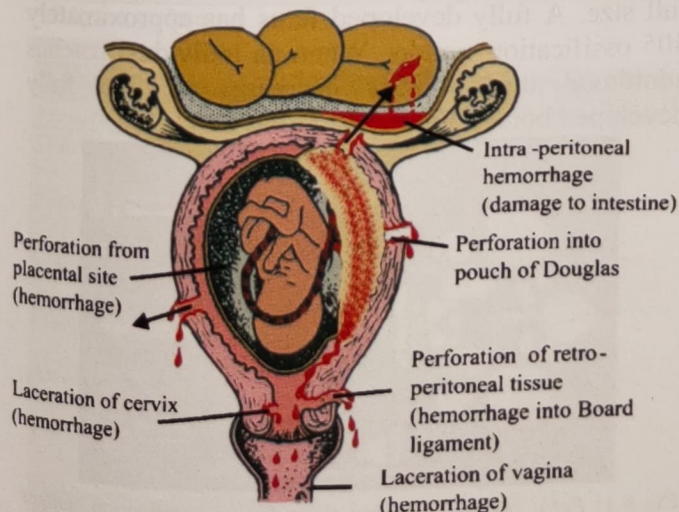


Fig 9.3: Death from rapid hemorrhagic complication

Delayed death is due to sepsis or other complications such as renal failure. These cases are first admitted to hospital prior to death of the women. Some cases may develop late complications like pelvic cellulitis or thrombo-phlebitis, which eventually cause pulmonary embolism and death. (Fig 9.4)

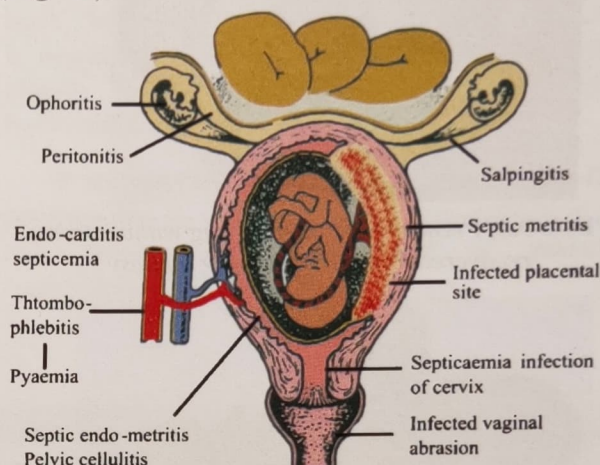


Fig 9.4: Death from infective complication

Autopsy finding evolution requires that medical practitioner should be conversant with type of drugs and instruments, which are generally used for such purposes, modes of death victims dies off and since subsequent postmortem findings have to be related with circumstantial evidence. Autopsy examination, in such deaths must be done as soon as possible. These bodies decompose early and unless this process is prevented, many difficulties may confront the medical examiner.

Findings are present both in clothes, body of the victim and in the fetus. Disarrangement of clothes should be noted. They are usually soiled with fluids including blood. When body is moved, a quantity of fluid may run out of the vagina soaking through all clothes lying beneath the buttocks. There may be smell of carbolic soap or an antiseptic like dettol in the room. Signs about stage of pregnancy should be ascertained if the fetus is still in the uterus. Vulva, vagina, cervix and uterus should be examined for any evidence of instrumentation, perforations and drug action. These injuries may be from a scratch to frank wounds of labia, vagina, cervix or uterus. Bleeding from the cervical canal is very common. There may be fluid in vagina and uterus. This fluid must be preserved for laboratory examination. If fetus is present, an estimation of its age made and also presence of trauma to the body of fetus noted. In case only fetal remnants are found, they should be

examined both grossly and microscopically. (Photo 9.3 & 9.4)



Photo 9.3: Premature fetus still lying within uterus, recovered from victim during autopsy



Photo 9.4: Full term fetus grossly lacerated at chest, left shoulder during curettage

In deaths due to air embolism, there may be deep cyanosis and congestion. Frothy mucus tinged with blood may exude from mouth and nostrils. Air bubbles may be seen in the veins over uterus, which may crepitate. Air bubbles may also be present in inferior vena cava, right heart, pulmonary artery and cerebral and coronary arteries.

In death from septicemia, causative organism generally is *Clostridium welchii*, which is a normal saprophytic organism in the genital tract, but these strains may become pathogenic in necrotic tissues. Skin of such a victim has a characteristic yellowish bronze color due to deep jaundice. Death occurs in twelve to forty eight hours to a week in hospital after admission. (Table 9.7)

Table 9.7:

Causative organisms responsible for septicemia

- *Clostridium welchii*
- Anaerobic streptococci
- *E. coli*
- *Streptococcus pyogenes*
- *Staphylococcus pyogenes*

Ethical obligation while attending a case of criminal abortion is important. Disclosure of

information obtained during course of medical treatment is not justified without consent of patient. Further, there is a public duty as a citizen that police should be informed. Medical practitioner may go in a fix as to what course should be selected between preservation of secrecy and his public duty. Medical Associations are of the view that any information obtained during the course of medical treatment should not be divulged voluntarily without consent of the patient. In a suspected case of criminal abortion, patient should be encouraged to record a dying declaration if death seems imminent. Upon death of patient, matter should be reported to police immediately and certificate of cause of death withheld till conduction of autopsy.

Newborn baby in addition to family also having two important forensic implications:

- **Prenatal/ postnatal age**
- **still/live birth**

Prenatal/postnatal age is determined upon morphological indicators like body measurements of length and developmental stage of different organs and parts of the body. From 5th to 9th month, length of the fetus (vertex to heel) is a good indicator of age. From 7th month onward, when the fetus is legally viable, length, morphology and centers of ossification would determine whether fetus falls during prenatal or postnatal stage.

Skeleton is formed by development and growth of ossification centers within growing cartilages of long bone, which gradually gets replaced by bone. A long bone for example develops from a set of three ossification centers; shaft or diaphysis and one each at an epiphysis on either end. These three grow and will ultimately fuse together when individual reaches full size. A fully developed fetus has approximately 405 ossification centers. When an individual reaches adulthood that number decreases to 206 fully developed bones (Fig 9.1 & Table 9.8)



Fig 9.1: Fetal skeletal remains (long bones, ossification centers and developing teeth) indicating age of new born as full term.

Stilllive birth proof depends upon the condition of fetus at the time of birth. Evidence of maceration or gross abnormality precludes live birth. Further the condition of chest, lungs, digestive tract and circulatory system may help in this evaluation. Before start of respiration, the chest is unexpanded and the lungs are airless. They do not fill the chest cavity and do not overlap the heart. They are small, hard and do not crepitate. Edges of the lung are sharp resembling those of liver.

After respiration, they fill the thoracic cavity fully, overlapping the heart, become spongy in consistency and crepitate. Their edges get rounded and color becomes mottled light and dark red. On section, bright red blood and froth escapes. Flotation or hydrostatic test and microscopy are reliable investigations to decide aeration. For microscopy, the

lungs should be removed and placed at once in fixative without excessive handling. Section shows expanded alveoli, which readily differentiates such lung from the one, which has never respired. Microscopic examination has an additional advantage that it provides evidence of pulmonary disease or abnormality, which may have caused death. In still birth, the alveoli appear collapsed and hydrostatic test is negative. After the child has taken a breath, the alveoli being expanded have air in them and hydrostatic test becomes positive.

It is important to exclude this test being falsely positive due to the presence of decomposition gases and falsely negative because of pneumonic consolidation. (Table 9.9)

Table 9.8:

Morphological indicators of fetal maturity

Intrauterine age	Morphological indicators
1 month	Embryo size about $\frac{1}{3}$ inch, embryo fully covered with chorionic villi, short and flat limb buds
2 months	Nose and mouth separated, external ear visible, hand formed, fingers distinguishable as slight projections
3 months	Fetal length about 4 inches, sex distinguishable, eyelids closed, placenta formed
4 months	Fetal length about 7 inches, placental weight about 3 ounces, hair and nails visible, papillary membrane present, center of ossification present in calcaneus
5 months	Fetal length about 9 inches, fetal weight about 1 pound, placental weight about 6 ounces, vernex caseosa visible
6 months	Fetal length about 11 inches, fetal weight about 2 pounds, placental weight 8-9 ounces, skin wrinkled and dirty red, eyelashes and eyebrows visible, size of external ear about 18 mm
7 months	Fetal length about 13 inches, fetal weight about 3 pounds, placental weight 11-12 ounces, skin still wrinkled, pupillary membrane starts to disappear, center of ossification present in talus
8 months	Fetal length about 15 inches, fetal weight about 4 $\frac{1}{2}$ pounds, placental weight 14-15 ounces, skin completely covered with vernex caseosa, nails reach ends of fingers, length of external ear about 25 mm, papillary membranes absent, center of ossification present at the lower end of femur
9 months*	Fetal length 16-18 inches, fetal weight 6-8 pounds, placental weight 16-18 ounces, skin pale, nails project beyond fingers, head measurements: width 3-4 inches, length 4-5 inches, circumference 13-14 inches; anterior fontanelle open, posterior fontanelle closed, scalp hair about 1 inch long, testes in scrotum in male, labia close vagina in female, meconium present, center of ossification in lower end of femur $\frac{1}{4}$ inch in diameter, small center present in cuboid

* Fully mature fetus

Table 9.9:

Differential features of breathed and un-breathed lung

Feature	Un-breathed lung	Breathed lung
Size	Small (one seventieth times of body weight)	Large (4-6 size bigger)
Color	Uniform, deep violet	Mottled and lighter
Consistency	Hard and non-crepitant	Spongy, elastic and crepitant
Edges		Sharp
Air sacs	Rounded Not visible	Visible and of uniform size
Cut surfaces	No froth on squeezing	Froth on squeezing
Flotation	Negative	Positive
Microscopy	Alveoli collapsed	Alveoli expanded

Besides above, differentiation between still/live-birth, attention should be paid to

- Presence of food in the stomach
- Air in gastrointestinal tract
- Changes in fetal blood vessels
- Vagitus uterinus

Child during labor while attempting to breathe swallows air. Flotation test can be performed on stomach and a portion of intestine after tying at both ends of segment taken from the tract. Evidence of presence of air in stomach can also be demonstrated by opening it under water and by radiology. Closure of foramen ovale, ductus arteriosus and ductus venosus, which are patent at birth, is a vital change.

Microscopy helps this detection. Vagitus uterinus is cry of child after inspiration while still in birth canal and this cry is sign of live birth. (Photo 9.1)



Photo 9.1: Still birth fetus with cord and placenta
Newborn age can be determined from:

- Size and shape of head
- Meconium in anal canal
- Degree of drying of *umbilical cord*
- Functional aspect of circulation.

Caput succedaneum is a projection on head of fetus formed during birth in cases of head presentation and age is assessed initially from size of *caput succedaneum*, which disappears in 2 to 3 days after birth. Meconium is a dark green colored material of intestinal secretions and amniotic fluid that is present in intestine of full term fetus and it continues to discharge for up-to 3-4 days from rectum. Drying of umbilical cord begins after birth and continues for few days. A ring of hyperemia due to inflammation is formed around place of its attachment, which becomes fully developed by the third day and sloughs off in 5-6 days. Foramen ovale and ductus arteriosus are patent at birth and gradually gets closed and organized by the third week.

Sexual offences and medical examinations of victim and offender have a special place in forensic medicine. Law clearly differentiates between legal and illegal sexual intercourse with further distinction of whether done per vagina including rectum. In offence of zina, both male and female are equally guilty while in case of zina-bil-jabiar, aggressor who does the act without will and consent of the partner is to be blamed and punished. Another happening in such cases is that female may also be violated at both vaginal and anal orifice and even in mouth. The medical examination should not be limited to genital region alone and will depend upon the allegation.

Medico-legal investigation of these cases should only be with those who are trained in the field. It is joint responsibility of law enforcement and medical authorities. They should have close working relationship between them from collection of evidence from the scene, till final interpretation of findings of medical examination. Such acts are usually done without witnesses and only parties present are victim and assailant, Statements of both should be listened to carefully and evaluated objectively. Besides, false allegation should also be kept in mind. A female may deny consent after having given it for fear of parental and other social considerations. She may also deny having given consent after subsequent pregnancy.

No age is immune for victims. A victim may have injuries on other parts of the body even when episode is consented and in genital region especially in virgin females. If a woman is used to sexual intercourse, there may be no injuries in the genital region. In such a case, confirmation of allegation will have to be resolved on presence of semen. In case assailant or victim has changed clothes, has bathed or washed private parts, sample will become negative.

Forensic medical examination of both victim and offender should be done immediately after obtaining written consent from them. It is undertaken in proper medical surrounding by qualified medical practitioner and should be thorough, complete in all respects and conducted in good order along with collection of necessary specimens, because outcome of the criminal case will depend upon it. In case of a female victim, a female attendant should be present during examination. Medical practitioner should plan the entire examination procedure adopting a scheme, which meets all essential requirements of the individual case with the objective that no material of evidential value gets lost.

Protocol of examination of male and female is almost similar but findings of genital regions differ, Female victim is usually brought first and whenever the suspect becomes available, same doctor should examine him. It is essential to appreciate the disproportion in the physical state of the assailant and victim and consistency of resultant damage.

An attempt should be made to grasp about general physique and emotional state of the examinee, while he or she is seated in a chair. Details of dress examined include all type of clothes worn and their material should be noted. If the victim is

female, attitude and behavior of the victim is important and should also be carefully observed. Attention should be paid to the extent of make-up. In these cases, evaluation of mental status is both essential and important as such assaults cause more psychological damage than physical trauma.

Steps of examination of sex organ in case of male are limited to inspection and palpation, where as in case of female, steps include inspection, palpation and speculum examination. Palpation strategy for vaginal and anal canals is bilateral traction and digital examination. (Table 9.10)

Table 9.10:

Procedural steps and relevant details

Step	Relevant details
A. Pre-examination	
(i) Consent	Expressed
(ii) Personal identity of examinee	Bio data and identification mask
B. Medical examination	
(i) General impression	Dress, make-up and mental status
(ii) Specific and obstetric history	Allegation details, obstetric (in females)
C. Examination of cloths	Undressing, condition of clothes and any trace evidence
D. Examination of body	
(i) General	Built, stature, vitals and injuries
(ii) Systemic	All organ systems
(iii) Genital	Genitalia including anal canal* and any foreign deposits (biological or other)
E. Specimen collection from clothes, body and genitalia	

* Not a part of genitalia, included due to its involvement in sexual violation.

Specific history of allegation should be listened carefully. It should include relevant recommended questions, "What was the time and place of the act? Who removed the clothes? What were the relative positions during the act? Was there pain during or after the act? Was the act performed by one or more persons? Was any violence used by the assailant/ assailants? Was penile penetration partial or full and whether ejaculation took place outside or inside?"

Obstetric history includes information about medication especially within the last twenty-four hours; previous sexual experience; menstrual status and cycle with dates; marital status, and previous pregnancies and childbirth's with dates. Inquiry about change of clothes, general bath or washing of the genitals should be made.

Female victim of zina-bil-jabr is emotionally very tense, withdrawn, depressed and entertains suicidal ideas. She may become reluctant to narrate the incidence, as recall is painful and requires, support and encouragement to overcome this feeling.

Examination of clothes should be done making the examinee stand on plain white cloth free from any contamination. Undressing should be done unaided by the examinee herself while standing on the sheet to avoid loss of trace evidence. Any items or material dropped during undressing should be collected for further examination in the laboratory to confirm the source of origin. Clothes after undressing are spread in day light and inspected for any derangement, damage and staining. Notes should include type and extent of damage as well as site and nature of staining. Wet stain is air dried and encircled with permanent marker before dispatch to the laboratory.

General examination of the body includes notes about height, weight, built and vital signs. Besides, skin of the whole body is inspected while the examinee is still standing on white sheet to locate injuries, stains, loose hair or any other form of trace evidence. Injuries present on the body of the victim may be bruises, abrasions or bite marks and should be palpated for tenderness.

Bruises, in female victim, are on her hands, forearms and arms mostly due to gripping exerted by pressure of finger tips; on medial sides of knees or thighs due to an attempt to separate them and on hips, cheek and breast caused during scuffle.

Abrasions are due to friction against hard surfaces and are usually on the back of the body in female victims and on the back of elbows and front of knees in victims of sodomy. Nail scratches are usually seen on the body of the assailant on the face and around the genitals.

Bites marks are imprint abrasions inflicted by victim on the body of the assailant and are usually seen on the neck and front of chest.

Stains in sexual assault of biological origin are semen, blood and saliva or non-biological especially of environment origin like soil, vegetation and oil. Seminal and bloodstains are located mostly on the thighs and area around and within the genitalia.

Loose hair from either partner may get transferred and entangled in the other's intact pubic hair which are collected by combing. Loose head hair may be found anywhere on the other's body.

Systemic examination of both the assailant and the victim should be done in all types of cases and is necessary to rule out the possibility of subsequent false defense plea by the assailant on the grounds of physical inability or any systemic disease.

Genital examination is the most important of all other examinations and the findings of vagina and anal canal will depend upon physical disproportion between these canals and the penis of the accused and upon the extent of physical violence. Factors like time interval between the sexual act, previous experiences of sexual intercourse, first aid rendered after the act, change of clothes and washing of the parts modifies findings.

Vaginal examination requires proper positioning of the female victim. Place the victim in the lithotomy position and arrange the medical examination in properly equipped place for best results. Implements for this examination are lithotomy table, pedestal lamp, surgical gloves, specula's of various sizes, magnifying lens, Glister Keen glass rods for deployment of hymenal edges, swab applicators, test tubes, slides and containers. Light should be adequate. There are four stages of examination: **inspection, bilateral traction, digital** and **speculum examinations**.

Inspection should be done paying special attention to the condition of labia minora and majora, mons pubis and the adjacent parts of thighs to note any redness, swelling, lesion, bleeding or discharge from vulva. Injuries such as bruises or scratches, stains and loose hair in the area should be looked for. The pubic hair bearing area should be noted to see whether the hair are soiled or matted.

Bilateral traction of the labia makes the hymeneal edges visible. A female with intact hymen is called *Virgo intacta*. The intact hymen closes the vaginal orifice only partially. It is a membranous structure usually about 1 mm thick, varying from thin and parchment to fleshy and firm. Its edges may be straight, irregular, partly folded or fim-briated. (Fig 9.5)

First intercourse ruptures the hymen and laceration of tear of hymen is the main sign of loss of virginity (**defloration**). The site and extent of a tear is an important feature. The finding can be elicited by placing both thumbs at 3 and 9 O' clock positions and applying lateral traction to the introitus. This maneuver stretches the hymen at 6 and 12 O' clock positions and any tear at these areas become evident

and visible. The examination is repeated all around. The location of tear can also be facilitated by use of Glister Keen glass rods by placing its lit end on the inner side of the hymen and moving it along the edges. The instrument is also useful in differentiating recent from old tears. The translucency of the hymen becomes brighter at the site of old tears and is slightly blurred if the tear is bleeding.

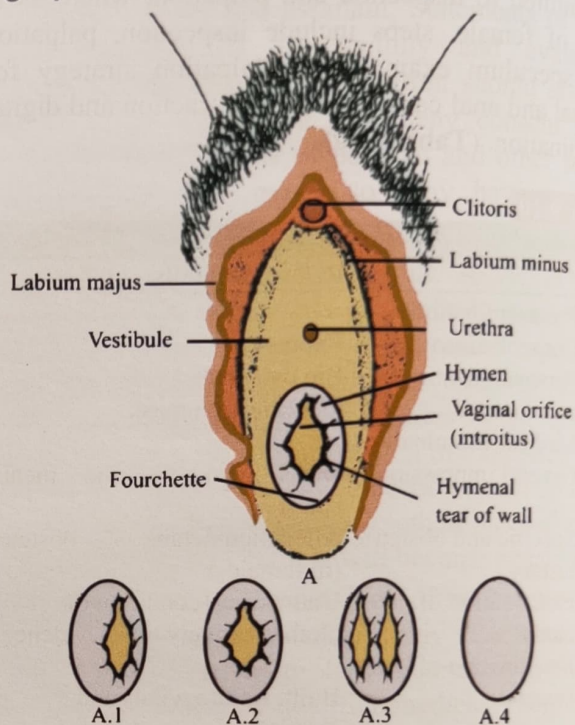


Fig 9.5: Diagrammatic representation of vagina
A. Fimbriate hymen having tear at 5 O' clock position.
A.1 Semilunar with large opening **A.2** Annular with a relatively smaller opening **A.3** Septate with two opening
A.4 Imperforate having no opening

Digital tears are incomplete and are generally situated either at anterior or posterior sites depending upon the manner of causation whereas tears due to sexual intercourse are complete and situated postro-laterally, rarely extending beyond the hymeneal attachment. Extended injury occurs in cases of great disproportion. If the victim is *Virgo intacta*, digital and instrumental examination must not be performed.

In rural and uneducated population, there is an erroneous belief that venereal disease gets cured by sexual intercourse with small children. They are violated comparatively more than adult women. Hymen in children is situated high up in the vaginal canal and therefore usually gets speared and does not rupture, but instead vaginal canal is ruptured posteriorly proportionate to disproportion of organs. It is observed that in such cases anal canal is also

violated. In cases of gross disproportion especially in children, vaginal lacerations may extend even into the perineum. (Photo 9.5)



Photo 9.5: Vaginal and anal tears in a child

Digital examination is meant to gauge size, tone, any tenderness or laxity of the vaginal canal. The extent of laxity is usually assessed whether it admits, easily, one or more fingers. It is done by introducing a gloved index finger into the vagina and moving its palmar aspect over the vaginal epithelium all around to note the degree of lateral pressure over the index finger and extent of roughness on the bulb of the finger. The difference of tone and extent of rugosities is an index to differentiate habituated vagina from non-habituated one. The rugosities are absent in the habituated vagina along with proportionate dilatation of the vaginal canal.

Specular examination vaginal canal should be performed only in sexually experienced women. An appropriate sized speculum is introduced into the vagina to inspect the condition of vaginal mucosa, its roughness and to locate any bleeding, injury or any other condition of the vaginal mucosa. The cervical portion of the uterus can also be inspected during this stage. Vaginal rugosities are marked in virgins and they gradually flatten proportionate to number of sexual intercourse and get almost obliterated after birth of children. The examination may be painful in cases of recent injury. It is emphasized that this manner of examination is the only way to inspect the vaginal mucosa, thus cannot be omitted. The bruises of the vaginal mucosa appear as dark brown areas mostly on the anterior wall in the upper third, being consistent with penile penetration.

Cervical abrasions due to digital interference and erosions due to disease should not be confused.

Cervical erosions are visible as red areas situated on the external surface of the cervix along with other signs of inflammation.

Anal examination is performed in knee-elbow position; its sub-stages are similar to those of vaginal examination.

Inspection of anus is to know its condition. It may be shaven, bear bruise, fissure or show inflammation. Also look for any seminal stains. Normal anal orifice is a slit like opening and the surrounding skin shows marked natural folds due to the corrugator cutis ani muscle. Local sign of the first anal intercourse is redness, bleeding, tear of anal skin and the underlying sphincter. Anal tears or fissure may also extend into the anal mucosa. (Fig 9.6)

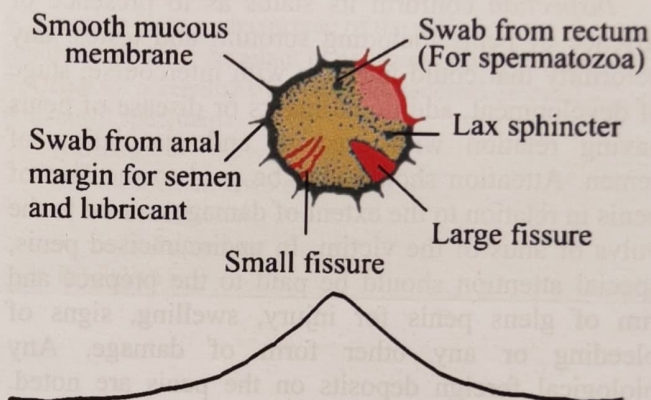


Fig 9.6: Inspection of anus for presence of any damage like fissures or soiling with blood and semen

Bilateral traction of anal sphincter with the help of thumbs of both hands locates the position of any anal tear or fissure. Anal tear becomes visible as triangular damage having base towards the centre of the canal. Illumination given blow demonstrates the manner indicated by arrows of the applications of uni-lateral traction with single thumb and by-lateral with both thumbs. (Fig 9.7)

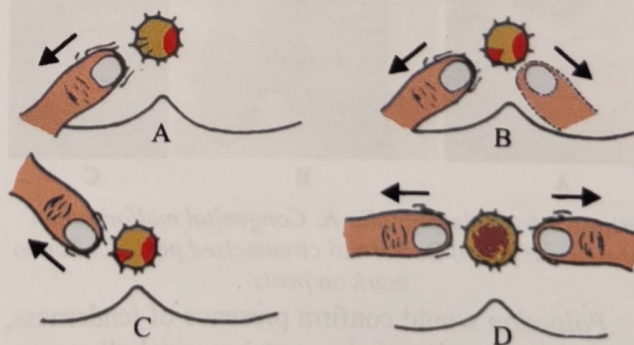


Fig 9.7: (A & C). Uni-lateral traction with single thumb and (B & D) bilateral traction with both thumbs

Digital examination of damaged anal canal is painful. It indicates size, tone and extent of dilatation of anal sphincter. A habitual's canal is lax, showing absence of normal anal folds and margins appear smooth. Anal canal is patulous and may also be infected.

Specular examination of the anus is done with an appropriate sized procto-scope. It is introduced and then gradually withdrawn to visualize condition of anal mucosa for any finding like presence of any bleeding, bruising and soiling. Bruising of the mucosa appears as dark brown areas.

Male genitalia are examined in two stages; **inspection** and **palpation**.

Inspection conform its status as to presence or absence of penis including scrotum and testes, any deformity that could interfere with intercourse, stage of development, additional marks or disease of penis having relation with erection and ejaculation of semen. Attention should also be paid to the size of penis in relation to the extent of damage caused to the vulva or anus of the victim. In uncircumcised penis, special attention should be paid to the prepuce and rim of glans penis for injury, swelling, signs of bleeding or any other form of damage. Any biological foreign deposits on the penis are noted. Extent of pubic hair growth along with soiling or matting and presence of loose hair should be observed. In absence of gross pathological lesions of the penis and scrotum, assailant would be considered capable of performing sexual intercourse. (Photo 9.6)

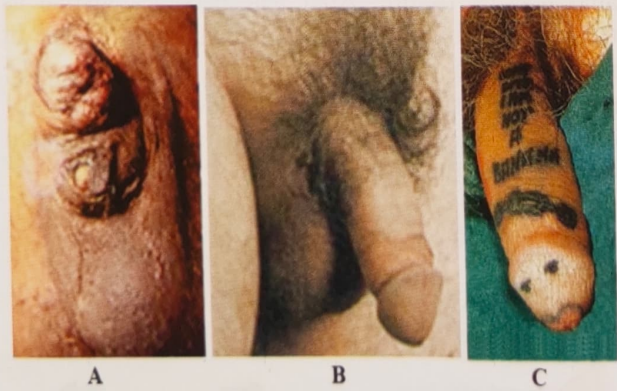


Photo 9.6: Male genitalia **A.** Congenital malformation (absence of penis) **B.** Normal circumcised penis **C.** Tattoo mark on penis

Palpation would confirm presence of tenderness, state of penis and testis in scrotal sac including non-descent, hernia, testicular atrophy or any testicular lesion. Vaginal epithelium may stick onto glans penis

and can easily be detected by painting it with dilute iodine solution. Vaginal epithelium stains dark brown. Besides determination of status of genitalia, injuries especially nail and bite marks should be looked for on other parts of the body such as face, chest and breast at the height of face of victim. (Photo 9.7 & 9.8)



Photo 9.7: Teeth marks on left cheek of male victim of sodomy

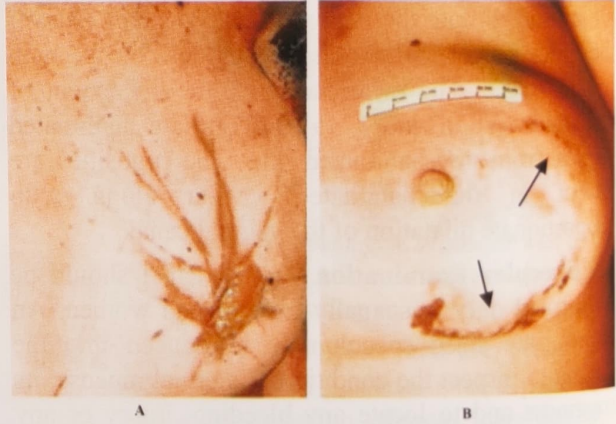


Photo 9.8: Two female breasts **A.** Having sharp edged cuts around nipple and also multiple radiating outward **B.** Teeth marks over breast (marked by arrows)

Secondary sex characters like extent and quality of hair growth on the face, chest and axillae of assailant should also be noted to assess maturity and ability to perform sexual intercourse.

Collection of specimens from victim of sexual assault is done during the course of examination to confirm allegation and also to link victim with the scene and assailant. If list of specimens is not comprehensive, objective of linkage will not be achieved. Besides, control from alleged source should also be collected for comparison.

In case of sodomy, specimens from the victim are clothes having stains, and or any other part of the body mainly perianal, anal and lower rectal swabs. If any loose hair is present in the perianal area, it should be collected as trace evidence. Essential specimens from the assailant, besides those from other parts of the body, are swabs from external urethral opening, glans penis, rim of the glans and penile shaft. Clothes should be inspected for any soiling by environmental factors as well as seminal stains, which are commonly found on the trouser or shalwar and inner surface of lower part of the shirt. Fly of the trousers is usually stained with semen. (Table 9.11)

Forensic Medical certificate in these cases should include both positive and negative findings and opinion must be based on the recorded data. If damage to vagina of female victim is proportionate to size of the penis of the assailant, it should be clearly certified, stating that medical examination findings are consistent with the allegation.

Table 9.11:**Comprehensive list of specimens**

1. Clothes entire lot (bearing stains and soiling)
2. Loose and matted hair
3. Swabs
 - i) From the body
 - a) Seminal stains (areas other than the vagina)
 - b) Salivary stains from the bite marks
 - ii) From the vagina
 - a) From introitus, perineum
 - b) From lower vagina, (separating the labia minors and passing a swab just into the area above to the hymenal boundary)
 - c) From high vagina
 - iii) From anal margins
 - iv) From the posterior fomix (with speculum into vagina on an applicator)
4. Scraping from undersurface of the nails (epithelium of the assailant in non-consenting victims)
5. Urine for screening of drugs and venereal disease,
6. Control specimen
 - i) Blood
 - ii) Plucked hair (two each)
 - a) Head hair
 - b) Pubic hair
 - iii) Saliva

CHAPTER 10

10. Forensic Certification and Medico-legal Clinic

Forensic certification is undertaken in pursuance of law for furthering justice and therefore emphasize that task is highly important and should be undertaken with extreme caution. There are two opposing parties to a case having immense interest to obtain certification in their favor. For this purpose both parties may exaggerate gravity of examinee's findings, concoct causation or modify allegation requiring entertaining low threshold of suspicious about history of allegation.

It is a specialized job having its own objective to achieve. Its importance lies in the fact that it is performed to avoid conflict over examinee's medical findings between two opposing and contesting parties'. Eventually certified findings of medical examiner are required in court of law for personal oral evidence on oath from certifying medical examiner to prove findings recorded in the certificate. As regards its record, it is confidential being mostly police/state cases and ordered to be kept in safe custody under lock, with no permission for issuing of its copy and maintained for twelve years (legal instructions) or till decision of the case.

Forensic certification should be undertaken with extreme carefulness only by trained medical examiner. Certified contents in the certificate should contain no error, done without external influence or money consideration. These examinations fall into three groups of medico-legal cases separated on the basis of the type's resultant from physical/sexual assaults and criminal intoxication during one's life and also those whose death occurred for same reasons.

Another small group contains certifications, which though fall within the domain of forensic medicine, yet are entertained by private sector medical practitioners, which is either right or not justified. (Table 10.1)

Table 10.1:

Forensic certifications by private sector medical practitioner

- Life insurance
- Driving license fitness
- Industrial injury/illness compensation
- Age determination for schooling, marriage, election (candidature/voter)

Task is not only important, but also difficult to perform. Observed findings both positive and negative including of investigations should be serially recorded in specifically designed performance certificate, strictly following under mentioned instructions:

A. General

- Examinee's consent obtained before actual start of examination
- Categorize case as to private/police or other authority, mentioning amount of fee charged and on whose behalf examination requested
- Record examinee's personal identity verified from CNIC and also from his two identification marks
- Examination of female (sexual assault) undertaken in the presence of a female attendant and un-dressing done by herself to avoid allegation of assault

B. Procedure of examination

- Assess examinee's physical and mental health status at the time of examination
- Locate and record details of observed findings in examinee's cloths, over his body, weather of trauma, sexual assault or intoxication
 - i) Examinee's worn cloths type and condition weather disturbed, torn, bear knife-cut/bullet-hole or stained with blood/semen or any other material like grit particles
 - ii) Examinee's trauma type and number (injuries) or related sexual assault or intoxication findings
 - iii) Observe presence/absence of any evidence in examinee's cloths and on body like blood, semen or other such as hair and synthetic fiber, collect and preserve evidence present

C. Investigations for

1. Clinical health status

2. Special forensic considerations:

(a) Physical assault, mostly X-ray for:

- i) Suspected bone fracture/joint dislocation
- ii) Location of short-charge (bullet/pellets) in body part/chest for presence of hemo-pneumo-thorax

(b) Sexual assault, mainly collection and preservation of trace evidence mostly of blood, semen and hair/synthetic fiber from victim's and assailant's cloths and their private parts for confirmation of source of trace evidence

(c) Intoxication, collection and preservation of material like victim's vomit, soiled cloths and first

part stomach-wash for confirmation of presence/absence of intoxicant.

Place of forensic examination should be purpose-built of its own design like other clinical examination places such as ophthalmology, gynecology/obstetrics to receive physical/sexual assault and intoxication cases. Design of the place is guided by consideration that three medico-legal type's cases i.e. physical/sexual assault and intoxication both in living/dead state are received for forensic examination both in living state and also after death of victim. Both living and dead cases require specific protocol approach; procedure, technique and even place of examination. Places are accordingly should be provided and called as **medico-legal clinic** for living and **autopsy suite** for dead person. Both places should be equipped with respective logistics and supported with respective trained paramedics for correct and efficient results.

Medico-legal clinic building-design has following sections:

- Secretarial staff offices including rooms for reception/registration of examinee/relatives
- Forensic medical examiner's office including interview and medical record rooms
- Forensic examination clinics (three), one each for cases of physical/sexual assaults and intoxication
- Conference room with staff kitchen
- Paramedics' office with store rooms (two) for containers and exhibits

- X-ray examination arrangements including X-ray processing
- Toilets, both private and public
- Vehicles parking including ambulance and police mobile

Principle of allocates of various sections is in accordance with work-flow. Secretarial office inclusive of reception and registration is accommodated close to entry-gate to immediately complete documentation of all arrivals. It should have two airy and well illuminated rooms of reasonable size to separately accommodate examinees with accompanying relatives and escorting police. Forensic medical examiner's office, three forensic examination clinics of capacious, well ventilated and adequately lit spaces are placed centrally. This section is supported with resuscitation, sterilization and dressings for efficient management of cases of accidents, physical assaults, sexual assaults and intoxication. It should also have arrangements for interview and storage of medical record. Conference hall, medical secretary's and paramedic's offices, stores for containers and exhibits and staff kitchen are grouped together and located away from entry-gate to avoid public interference. Medical record being confidential should open only in the office of the Forensic Medical Examiner.

It is stressed that to produce correct results, forensic examination clinic should be equipped with proper instrumentation supervised by trained paramedics. (**Table 10.2 & Photo 10.1**)

Table 10.2:

List of medico-legal examination equipment

Type of examination	Equipment
Clinical examination implements	Stethoscope, blood pressure apparatus, tongue depressor, ophthalmoscope, clinical thermometer, weighing/height machine hammer and torch.
Physical assault examination implements	Steel measuring ruler/tape, magnifying lens (ordinary and illuminated), blunt/graduated probes and surgical dressings.
Sexual assault examination implements	Disposable gloves (all sizes), set of vaginal speculae, various sizes proctoscopy set, applicators, Glaister keen glass rod--ordinary & illuminated (for deployment of hymenal edges), pair of tweezers, glass slides, glass test tubes and glass containers
Intoxication examination implements	Sharp pointed and blunt needles, torch, hammer, laryngoscope, implements for stomach wash, specimen containers (various size).
Radiological equipment	X-ray machines--10 M.A. (portable), 200 M.A. (fixed) X-ray films, lead markers, hangers, automatic processor and illuminator

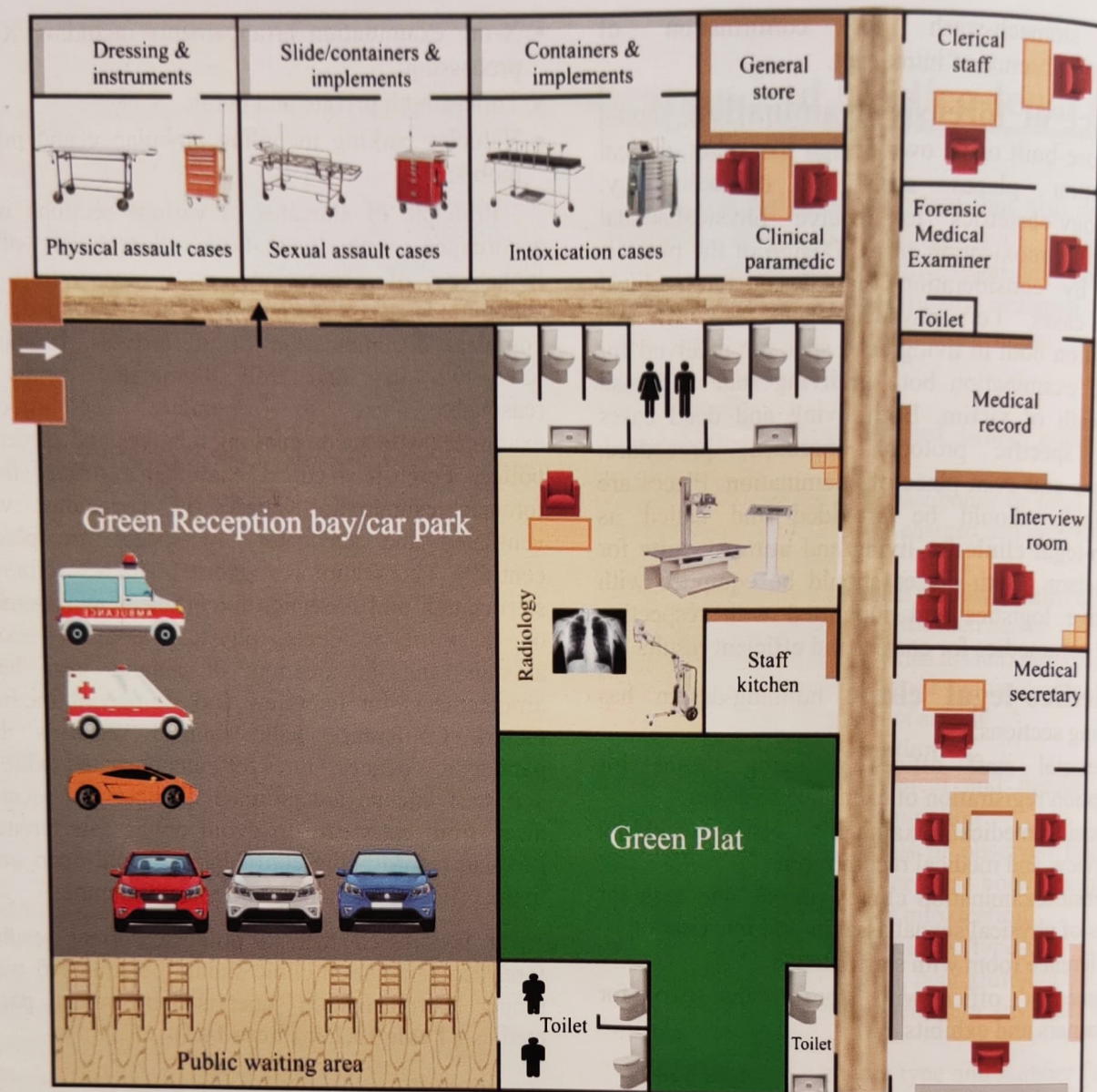


Photo 10.1: Standard medico-legal clinic design

Forensic radiology is specialized investigation to help seek out that what is hidden (bone fracture/ joint dislocation and firearm short-charge) providing permanent record acceptable to courts during practice of forensic medicine. High power equipment is not essential, because objects to be seen are inanimate. Automatic X-ray processing machine should be available at hand and radiology section should have lead laden walls to avoid harmful effects of radiation to workers.

Forensic certification protocol is grossly different from that of routine clinical practice. It includes recording of important areas like pre-examination formalities, examinee's medical examination and forensic certification for information of court. (Table 10.3)

Table 10.3:**Forensic certification performa design****A. Pre-examination formalities**

- Examinee's bio-data; date, time and place of examination
- Authorization and purpose of examination
- Examination fee
- History of case allegation
- Examinee's consent

B. Examinee's medical examination

- Personal identity
- General health and mental status
- Cloths condition inclusive presence of trace evidence
- Local examination of affected part/ body opening
- Clinical/forensic investigations

C. Forensic certification

- Documentation inclusive exhibits
- Formulation of opinion

Pre-examination formalities portion comprises of examinee's bio-data; date, time and place of examination, authorization and purpose of examination, examination fee involved and history of allegation of the case. These are described one by one.

Authorization and purpose of examination is necessary condition applicable to forensic medical examinations. Both are given and stated either by:

- i) examinee him/herself, who is custodian of his body
- ii) Agency having interest in examination. Usually such request is made by police, court and Government or an administrative authority of an organization such as industrial establishment, insurance company, bank or any other.

Examination fees involved is an important question. When forensic examination is requested by examinee him/herself in his private capacity, medical examiner should inform about total expenses involved as doctor's fee (according to his status) and cost of investigations before actual start of examination. In police cases, authorize medical practitioner in government service is not entitled to any fee. Courts usually convey, if medical examination is private or otherwise. Medical examinations on behalf of all other agencies are always done in private capacity.

History of case allegation pertains to details of incidence whether criminal physical/sexual assault and intoxication or accidental poisoning at industry during employment of worker. In case of physical violence, information about type of weapon, number of persons involved and circumstances including place of occurrence should be inquired. Complaints of the victim should carefully be listened.

In case of industrial occupation summary of workers complaints including work circumstances and about accident should be ask. Examinee should be allowed to tell his story without interruption. History of any similar illness in any other fellow worker should also be inquired. It is wise to have the occupational history from the time of first occupation and record the duration of all subsequent jobs with dates. It is most likely that noxious substance responsible for his illness may be found in his present occupation but should not be taken for granted. Precise circumstantial information regarding work should have details not confined to the most recent employment. The worker should be asked the name

of his trade or process employed, tools used the substances handled and for more details his manager or works chemist should be asked. Some industrial materials are cumulative having a long clinically silent latent period. Protective devices and protective clothes used at work should also be inquired about by asking to explain or draw a sketch or plan of his work place. It will help know the route of entry of intoxicant. The details about the accident should be obtained from the worker, employer and other witnesses of accident or experts in the field such as a mining engineer should also be consulted.

Examinee's consent (written) is an essential requirement and medical examination can only be performed after his/her consent. When it is implied consent should also be recorded for evidential purposes. In case medical examination is to be done on behalf of an agency, it should be explained clearly to the examinee and only then his consent become valid. Expressed examinee's refusal for medical examination or willful absence on notified date of examination, matter should be intimated to the agency asking for such medical examination.

Examinee's medical examination is largest part in forensic certificate regarding examinee's personal identity; health status, presence of any trauma due to physical assault, traffic and industrial accident, physical/psychological damages examinees person resultant from sexual assault or sign/symptoms due to intoxication:

Examinee's personal identity is verified and recorded by entering examinee's national identity card number. Additionally two permanent identity marks on his/her body should be searched and there full description about its color, size and relationship to fixed bony landmark should be recorded.

Examinee's cloths, their condition inclusive presence of any trace evidence in them has special place, weather disturbed including torn, bear knife-cut/bullet-hole or stained with blood/semen or any other material like vomit, fecal matter or earth grit particles. They are searched to locate foreign material on them. When clothes bear stains of blood, semen, hair or fiber, vomits/excreta, or any other material, its position, color and distribution are recorded. Above evidence is sought both with naked eye as well as with the help of a magnifying lens. Depending on its type and characteristics as to smell, feel, shape and texture should be recorded. Any cut or firearm whole in clothes, being an important finding regarding its

position and relationship to injury should be noted, damaged portion encircled, signed with permanent marker, photographed and then cloths preserved by air drying on hangers before they are handed over to police as case property.

General health is assessed by noting separately physical and mental status:

1. *Physical status* is important finding in cases of trauma due to assault/accident (traffic/industry) and intoxication and assessment made accordingly:
 - (a) Cases of trauma needs recording of body temperature, blood pressure, pulse and respiratory rates with their character, presence of skin paler, sweating, nausea and vomiting and pupil's reaction to light
 - (b) i) Actually intoxicated patient's are either unconscious, comatose or even in convulsive state also manifesting disorientation depending upon intoxicant
 - (ii) Chronic poisoning including industrial worker's occupational toxicity/disease following exposure to an intoxicant over a long period manifests weakness, anemic ill health in general sense.
2. *Mental state* is important in cases of patients suffering from a) psychological illness b) victim of intoxication and c) sexual assault. It is assessed by noticing variation of mood, concentration of mind, orientation about space and time, victim's behavior and psychomotor response.

Psychological illnesses diagnosis is a highly specialized job and in such a case suspicion, opinion of psychiatrist should be obtained. In case of intoxication, from specific sign/symptoms that occur and in case of sexual assaults, victim especially female is mostly depressed and may entertain suicidal ideas. Psychomotor responses in such a case are retarded with disturbance of concentration of mind. Victim may be confused showing thought block and may feel difficulty in expressing even the allegation.

Investigations, which are necessary as standard protocol to avoid defense alibi of inability in physical and sexual assaults are blood, urine, X-ray chest and ECG. In comparison forensic investigations are those, which are specifically connected with relevant examination. They are X-ray of bone or joint to know site and type of fracture or dislocation in relation to an injury, presence or absence of component of

ammunition in body part following wounding by fire-arm. They provide permanent record and are acceptable as evidence to Courts of law. Report of investigations and X-ray films with reports should be preserved as exhibits and enclosed along with final certificate. Stomach wash is material of choice in all living cases of poisoning. Entire quantity or at least 500 cc is collected in a chemically clean glass container. Capacity of the container should not be less than 1000 cc. Container should be filled to two thirds of its capacity leaving upper one third of the space free for collection of gases. Stopper should be of screw type. No preservative is used.

Local examination of affected part and body opening are essential in cases of injuries and sexual assault. Affected body part is that has pathology like wound caused during physical assault, road/industrial accident and a body opening is that has been violated during sexual assault. Body part is examined using strategies of **inspection** and **palpation**. Inspection is done both with naked eye and with help of a magnifying lens having reasonably significant magnification. Palpation would confirm presence or absence of any foreign body. If present it will require further investigation to clench diagnosis of location and type foreign body. Incised wound examination has special reference about its site whether accessible or not by working hand, number whether single or multiple, distribution whether arranged parallel or random should be noted carefully for determination of possibility of wound being self-inflicted, suicidal, homicidal or accidental. (**Table.10.4**)

Table.10.4:

Wound characteristics

- Site in relation to fixed bony land mark and whether accessible or not by working hand
- Shape whether closed or open and if open, whether circular, oval, elliptical or irregular
- Measurement of length, breadth and depth, which is estimated by a blunt graduated probe, except in the penetrating wound of body cavities of the head, chest and abdomen
- Direction in relation to the plane of the body
- Characters of the margins, walls and bed, whether smooth and cleanly cut or lacerated
- Number whether single or multiple, if multiple their distribution whether arranged parallel or random
- Any foreign material within
- Direction of bleeding flow on the clothes and body of victim
- Presence of inflammatory reaction and its extent

Body openings of vagina and anus routinely and mouth in some cases are criminally violated and their medical examination becomes essential. Vagina and anus openings are best examined in lithotomy and knee-elbow position respectively. Illumination should be adequate for good results. There are four sub-stages:

- Inspection
- Bilateral traction
- Digital manipulation
- Instrumental scrutiny

Inspection includes notes about physical status of vagina and anus, any abnormality in them and their surrounding areas for presence or absence of any foreign material like stain of blood, semen and hair or any other thing. Hymen is not visible during the stage of inspection. For scrutiny of interior of these canals, bilateral traction, digital manipulation and instrumental examination are recommended.

Bilateral traction to margins of openings is applied by placing both thumbs and fingers just lateral to their margins and pulling them apart. It will stretch margins exposing skin-mucosal junction as well as interior of first part of these canals to know whether normal or damaged. In case of anus its tear becomes visible as triangular damage having base toward the lumen of the canal and in vaginal canal, hymen rather in stretched form shows clearly its margin as well as any tear in it. (Photo.10.2)



Photo.10.2: Bilateral traction of anus canal showing bruising of margins and posterior tear

Digital manipulation is performed next, by introducing a gloved index finger into the canals. It is to gauge size of the openings, feel tone of the canals and character of its mucosal surface. Opening of hymen in the case of virgin is of the size that admits only tip of the little finger and if it is intact, digital examination should not be done. After sexual intercourse, conditions of these canals change proportionate to the number of sexual acts and also

whether occasional or regular. After regular use, both vaginal and anal canals become larger, lax and mucosal surface is flattened.

Instrumental scrutiny of vaginal and anal canal is done with a suitable sized vaginal speculum and proto-scope respectively by introducing instrument and then gradual withdrawing it. This procedure exposes interior of these canals fully and confirms findings visually. It also locates type and extent of damage within deeper portion. Blood or semen stains if present within canals are collected upon cotton swabs fitted on applicator and air dried to avoid decomposition.

Documentation of findings is mandatory. All findings should be documented as written record, sketches and photographs, wherever necessary. Close-up of injuries, damages and staining of clothes and full view of injured or intoxicated are essential. Fractures should be recorded on X-rays. Besides, findings observed, it should include results of investigations. Reports on collected material and all other relevant documents such as receipts and dispatches must be placed in order and indicated by labels. In case injured is admitted in hospital, treatment notes, duration of the stay in the hospital and date of the discharge should be obtained from ward and this information incorporated in medical certificate so that full facts of the case can be certified.

In Pakistan forensic certificates are prepared in triplicate on specific Performa depending upon type of case by medical practitioner in his own hand writing and signed at the end mentioning name designation and address of medical examiner. Of three prepared certificates, original remains in register. Of the remaining two, one copy is handed over to investigating police after obtaining signatures on original and other is sent to statistical section for compilation of data.

Formulation of opinion is very important duty of medical examiner. Conclusion should be based on observed facts only. It is stressed that opinion should not go beyond knowledge of the medical examiner. In case of difficulty or inability to appreciate or elicit a finding or frame an opinion, matter should immediately be referred to a senior and trained specialist colleague for advice. Delay in seeking advice may be detrimental and may add limitations in evaluation of case even by a specialist either due to loss of evidence or onset of inflammatory and repair

processes or decomposition. Sentiments, sympathy or any personal theory must not influence formulation of the opinion.

Conclusion should contain comments about nature of causative agent along with estimation of time lapsed and gravity of damage inclusive of incapacity produced by trauma or intoxication. Opinion should also take into consideration the allegation by the examinee. In case of physical assaults, possibility of injury being self-inflicted, homicidal or accidental should also be recorded. In cases of sexual assaults it is necessary to record in remarks whether findings are consistence with sexual intercourse or they are otherwise. In industrial

poisoning, casual relationship is based upon preponderance of evidence rather than an absolute proof. Such inferences are vital information for administration of justice.

Forensic medical certificate has an essential corollary of court attendance. Its proper understanding require some knowledge of how medico-legal case is reported to police, what is medico-legal inquiry prior to medical examination, how case is dealt in court including challenging integrity of forensic certificate and how finally this issue is disposed off have been charted in Forensic Examination drill. (Chart 10.1)

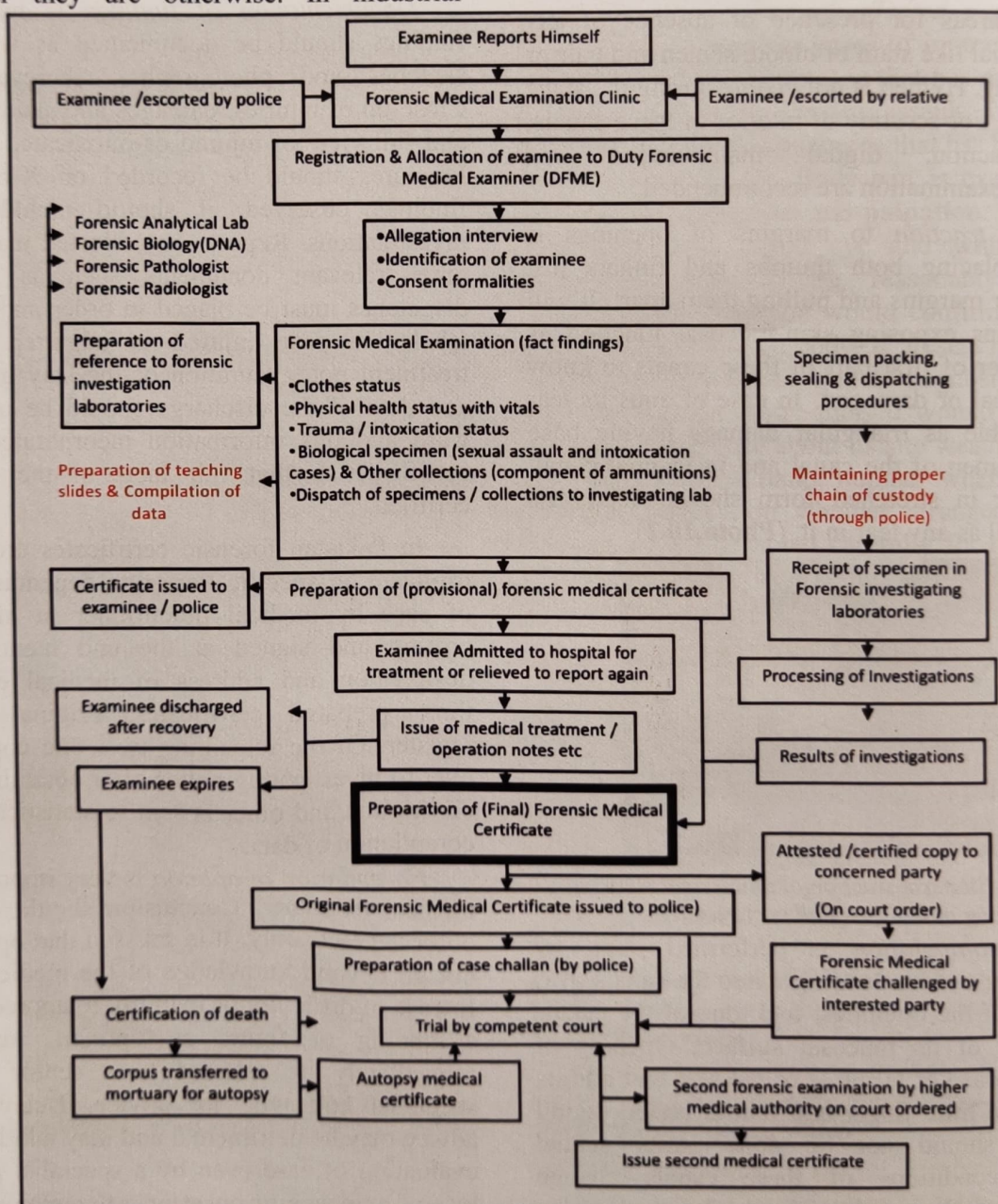


Chart 10.1: Forensic Examination drill

11. Forensic Autopsy and Autopsy suite

Forensic Autopsy is scrutiny of corpse consists of external surface, three internal body cavities including contents after opening them and further examination of collected body tissues/other material for histology, biochemistry and toxicology. Trend to dispose sudden deaths without autopsy is unscientific. Decline in autopsy rate is supposedly due to success of diagnostic techniques and removal of manifestations of malady during surgery prior to death. Diagnostic procedure of clinical pathology including hematology, serology, and histopathology, radiology including ultra-sonography, isotope scanning, computerized tomography and magnetic resonance imaging are now considered sufficient to know cause of death.

Havard and Heasman pointed out danger of disposing medico-legal cases without autopsy. They based their opinion upon comparison between clinical diagnoses with autopsy findings. It has 50% disagreement and in half of these cases, disagreement is of facts and not merely of opinion.

Types of autopsy are three; **medical autopsy, forensic autopsy, postmortem examination.** Forensic autopsy of suicidal cases has an additional requirement of **psychological autopsy.**

Medical autopsy is conducted for medical reasons to establish diagnosis in cases where clinical investigations during life of patient remained inconclusive.

Forensic autopsy is performed in pursuance of law to establish cause and manner of death and also to establish or rule out foul play in cases of deaths due to criminal assault, poisoning and transportation or industrial accidents.

Postmortem examination relates to external body surface examination of corpse by inspection without opening body cavities. However, specimens of body fluids like blood, bile and urine may be collected. It is an incomplete scrutiny, which not recommended and should be discouraged.

Psychological autopsy is special exercise in cases of alleged suicide. It is to know deceased's mental status at the time of his death. Report prepared by police in such cases is inadequate, because they are neither trained nor have

knowledge to collect such technical data and only interested in cases of homicide.

Such data includes deceased's background, character, habits, personality trait and quality of relationship with others. Sources for collection of this information are family members, teachers, friends, professional colleagues and his physician who is more knowledgeable and willing to cooperate.

Autopsy suite building/premises have to be technically designed and built properly and fully equipped and supported with adequate number of trained paramedical staff for conduction of forensic autopsies. It comprises of the following facilities:

- Reception/registration with vehicle parking, escorting police and public waiting area and toilet
- Large autopsy room having proportionate number of autopsy tables in accordance with area population served with Forensic Medical Examiner's office and autopsy record room
- Safe corpse storage with uninterrupted/continuous refrigeration prior to autopsy examination
- X-ray examination/film development arrangement
- Room of reasonable size for material such as containers, preservative, disinfectant, slides, instruments with arrangements of sterilization
- Offices for clerical staff and paramedics

Besides, there are other requirements like plenty of running water, sufficient light, numerous electrical outlets covered with water proof screw caps.

Autopsy suite design is guided by the principle that Forensic Medical Examiner's office and autopsy record room should be studded together for safety and security of record being confidential. Public waiting area should be placed near main gate; corpse entry/exit should be wide unobstructed and separate from entry door for public. Floor and walls of autopsy room should be impervious having ice blue tiles for ease of cleaning and washing. Thorough washing of autopsy room should be done after every autopsy. Water should come down from ceiling. Drainage from postmortem tables and floor of autopsy room should first lead into an open gully

before joining main drain system to prevent blockage.

Autopsy room light should preferably be natural sunlight coming from North. Alternately it can be from lamp specially designed with geometrically arranged chromium-plated parabolic raster system to obtain artificial day light at table level. (Fig. 11.1)

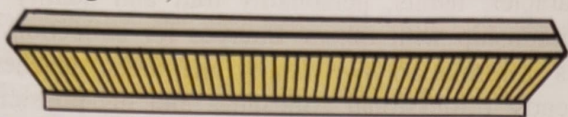


Fig. 11.1: Day light lamp with geometrically arranged chromium-plated parabolic raster system

In case of non-availability of daylight-lamp, ordinary ice-blue fluorescent electric tubes are recommended with a word of caution that amount of light should be sufficient to differentiate various skin shades due to disease, trauma and putrefaction. A minimum of 90 lumens at table level is considered sufficient.

Electrical outlets covered with water proof screw caps are necessary for safe use of electrical appliances like electric saw, X-ray illuminator, camera and video recorder.

Sterilization of autopsy room after washing with disinfectant should be by fixing ultra-violet light on wall near ceiling. While the ultra-violet light is on, nobody should be allowed to enter autopsy room and it should be kept closed. After a day's work, bacteriological test of walls and floors should be sterile.

Autopsy room ventilation works reverse. Air enters the room from ceiling and leaves through vents fixed in walls near the floor. Such arrangements reduce smell and help to prevent transmission of infection by inhalation. These vents should also have adjustable water proof covers. Medical students should not be allowed onto floor of autopsy room and be seated in viewing gallery having a separate entry. (Photo.11.1)



Photo.11.1: Students' viewing gallery

Autopsy room should always be kept ready, thoroughly clean, well ventilated, properly illuminated. It can be likened to an operation theatre with the difference that infection if any must remain contained within autopsy room. Staff should enter after wearing standard autopsy suits including rubber boots.

Corpse from outside to autopsy suite should be brought on corpse carrier/ambulance direct to refrigeration unit. When coming from within hospital, dead body should be transported on specifically designed stainless steel stretcher with a lid mounted on wheel trolley. On arrival, corpse should be transferred first on a stainless storage-tray with a linen sheet under the corpse to avoid adherence and only then tray is placed in the refrigerator. (Fig. 11.2)



Fig 11.2: Stainless steel stretcher with lid mounted on trolley

An infected dead body should first be enclosed in an airproof plastic body bag fitted with nylon zipper, labeled with warning ticket of red color and then placed in refrigerator. (Fig. 11.3)

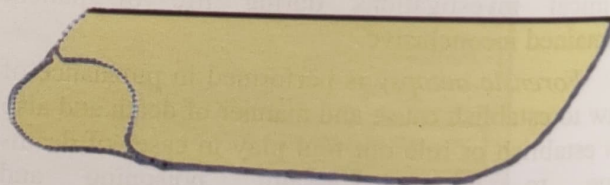


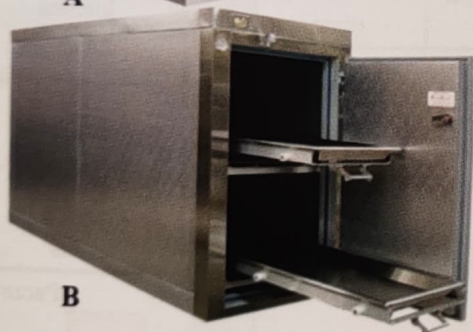
Fig 11.3: Airproof body bag

Mortuary refrigeration cabinets are designed as two, four or six-bodies-unit affixed either horizontally or vertically having large single or small multiple doors for each section. Mortuary refrigerator having small door is better. It has an advantage that opening of small door does not interfere much with cooling system. Mortuary refrigeration requirement for an autopsy center will vary according to workload and also policy of storing of the corpses. For an annual autopsy load of 100 corpses, six-bodies-unit is sufficient. If center entertains requests for temporary storage of

corpse for short periods of two or three days before disposal (burial/cremation), requirement will increase accordingly. Pre-autopsy temperature of freezer for corpse requiring microscopic examination of tissues should not go below $+4^{\circ}\text{C}$ to avoid freezing of the tissue. Post-autopsy temperature for longer periods should be kept around -20°C or even lower. Corpse's name-slip should be placed in identity-holder fixed on the door of section for its identity. Placement of dead body within mortuary refrigerator is facilitated by use of a hydraulic lift trolley. (Fig. 11.4 & 11.5)



A



B

Fig 11.4: Mortuary freezing units' (stainless steel) A. two bodies showing interior B. Six bodies showing exterior



Fig 11.5: Hydraulic lift trolley (stainless steel)

Corpse dissecting requirement essentially includes protective dress suit, autopsy table with instruments and others:

- *Autopsy table with instruments* are now made of stainless steel, which resist rusting. Porcelain autopsy table, which was previously used, is no more in use. It has a tendency to chip-off and prone to retain biological material in cracks. Metallic table is though expensive, yet preferred. It has the advantage of built-in flat perforated surface, large surround with water wash-down arrangements and exhaust canal connected to exhaust unit. Exploratory cutting, opening, washing and weighing of viscera should be done on a separate table with removable perforated surface and extraction basin. Plenty of running-water at the autopsy table should be available. Water should drain into washing-sink. Space around autopsy table should be adequate to facilitate movement of trolley during loading and unloading of corpses.

Sterilized set of recommended instrument and an additional reserve set should always remain available. Proper care of instruments is essential. Cutting instruments must be kept sharp. Other instruments having joints are not loose. Blunt and defective ones during work are dangerous. At the end of day's work, they are thoroughly washed with running water, blade of the saw cleaned with soft brush and should remain immersed in dilute 1:40 lysol for two hours before sending them for autoclave. (Fig 11.6, 11.7 & Table 11.1)



Fig. 11.6: Standard stainless steel autopsy table

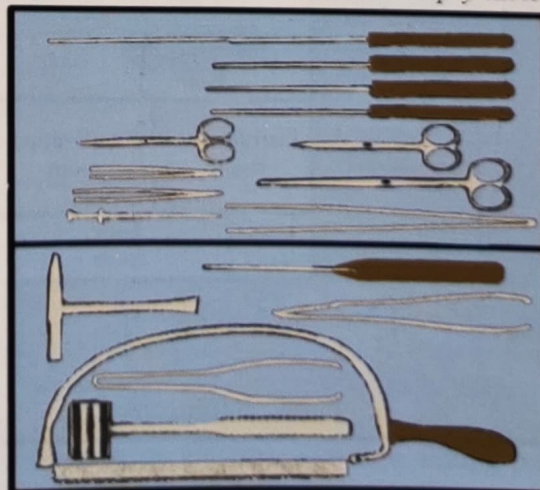


Fig. 11.7: Autopsy instrument set

- *Protective dress suit* consists of operating gown, plastic apron with hood and non-slip full length rubber boots made of water and airproof material. After day's work, boots are rinsed in disinfectant and scrubbed on outside with lavatory brush. All garments are soaked in disinfectant before dispatch to laundry.
- *Other requirements* are suction unit to collect and measure pleural, ascetic and other fluids and internal hemorrhage in body cavities and portable X-ray machine to locate fractures and inanimate bodies like bullets. (Photo 11.2)

Table 11.1:
Recommended list of autopsy instrument
Probes (general operator and straight)
Scissor (large, medium and small blunt-ended, pointed-ended and a pair with one blade having a hook extension for opening of the gut)
Forceps (blunt end 4 & 6 inch)
Knives (5 inch fixed blade and other having detachable blades, operating, amputating, cartilage cutting, and long knives from 12 to 24 inch blade for cutting of brain)
Urethral sound (curved and Van Burin)
Procto-scope (different sizes)
Shears, different types (for ribs cutting)
Hand and electrical saw
Chisel (small and large)
Hammer (small and large)
Post-mortem needles (half curved and cutting edged)
Sutures (different types)

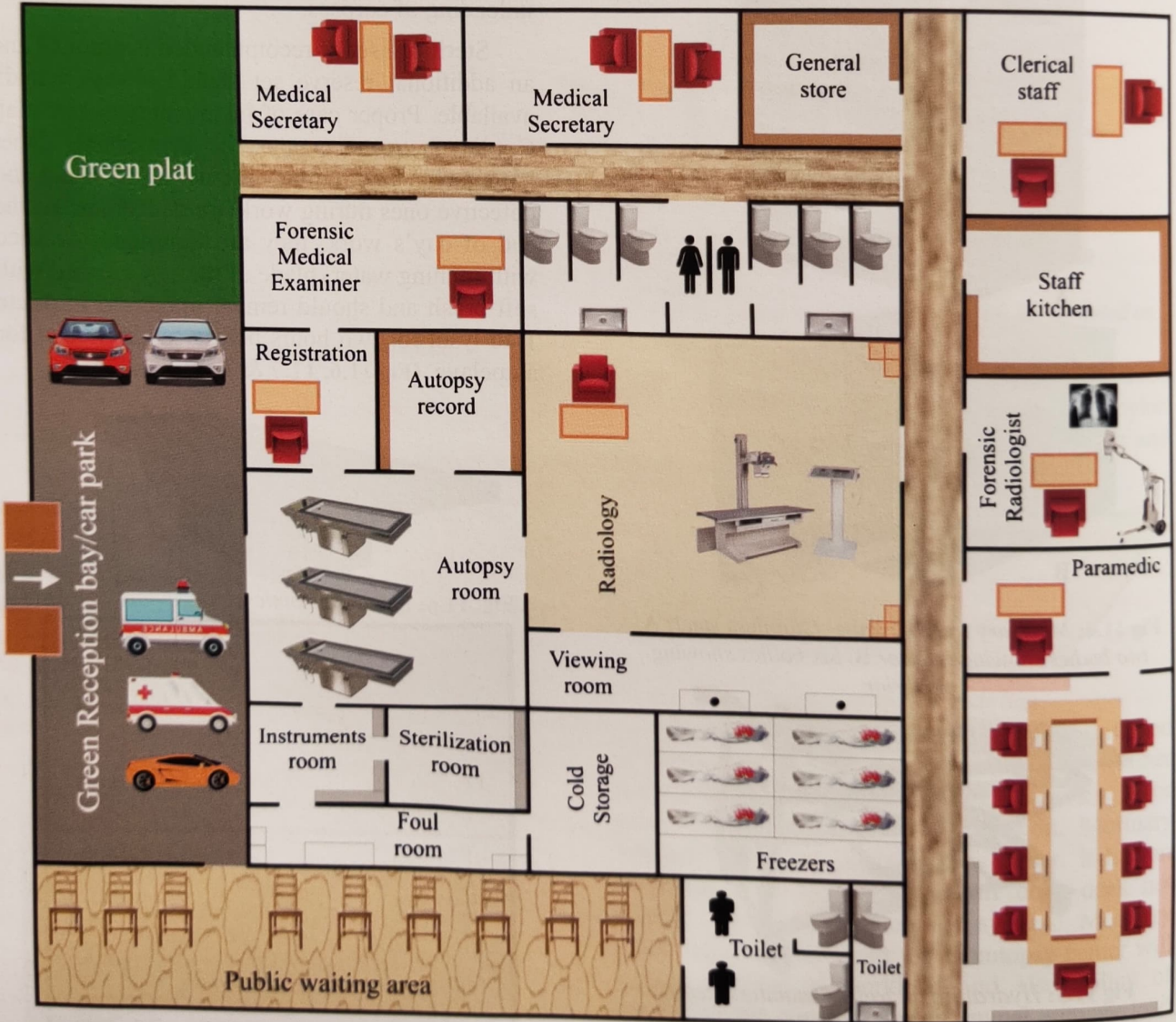


Photo.11.2: Standard autopsy suite

Forensic autopsy protocol is according to its specific objectives, which are establishment of deceased personal identity, determination of cause and manner of death and estimation of fatal and postmortem periods in deaths occurring due to suicide, homicide, transportation and industrial accidents. Before actual start of work, Forensic Medical Examiner should satisfy himself that written authority is addressed to him by name with designation. He should carefully go through reference and attached report. A reference and related information for performing an autopsy is generally sent either by investigating police, health authority or in rare cases court of law.

It is emphasized that forensic autopsy is a legal duty and highly responsible job, but in some cases arduous in nature as in dead bodies under decomposition. Further duty in autopsy room may become hazardous, endangering safety of workers requiring recognition of hazards. (Table 11.2)

Table 11.2:

Autopsy room hazards endangering safety of worker

(1) Mechanical Injury

- (i) Fracture of limb by fall on wet/slippery floor
- (ii) Needle prick, cut or burning of hand due to sharp /hot instrument, boiling water during dissection
- (iii) Back muscles sprain from lifting of heavy corpse
- (iv) Eye corneal ulcer by sawing dust from bone

(2) Biological**A. Bacterial infection from**

- (i) Septicemic and pyemic dead bodies
- (ii) Purulent fluids in cavities, abscess from organs and viscera
- (iii) Specific infections
 - a) Typhoid and paratyphoid
 - b) Tuberculosis
 - c) Leprosy
 - d) Anthrax

B. Viral infections

- (i) Hepatitis
- (ii) AIDS
- (iii) Fungal

(3) Chemical**A. Antiseptics and disinfectants***

- (i) Iodine
- (ii) Phenols fluid
- (iii) Dettol

B. Fixatives Formaline****(4) Electrical**

Electric burns due to faulty appliances, metallic autopsy table and wet floors

(5) Radiation

- (i) Electromagnetic radiation
- (ii) Ionizing radiation from therapeutic radioactive isotopes

* Concentrated solution for inanimate bodies like instrument, autopsy tables is high that burns skin on contact

** Living skin if stays in contact with fixative for more than 15 minutes also gets fixed

Forensic autopsy procedure is both art and science, requiring neatness and precision. It should be carried out with efficiency and proper decorum, dignity and respect for human body. Beside legal and moral considerations, it is highly technical exercise not to be attempted by untrained medical practitioner. He may end up confused about results, also adding additionally postmortem artifact, which in turn may lead to misinterpretation and wrong inference. Exercise is divided into three stages:

- **Pre-examination formalities**
- **Forensic autopsy inclusive investigations**
- **Certification of findings including documentation**

Pre-examination formalities include recording of corpse arrival in autopsy center, transfer of corpse to autopsy room and corpse personal identification.

Recording of date and time of corpse arrival is noted by authorized mortician, who makes entries in appropriate columns of two registers; **general register** and **autopsy register** under supervision of Forensic Medical Examiner. (Table 11.3)

Table 11.3:

Columns for corpse receipt in general and autopsy register

General register

- Bio-data of deceased
- Date and time of receipt of corpse
- Name, number and police station of escorting constable
- Date and time of return of corpse back to police

Autopsy register

- Bio-data of deceased
- Yearly autopsy number allocated to deceased
- Date and time of autopsy
- Name and number of specimens collected from deceased *
- Date and time of dispatch of specimens and name of laboratory where sent *
- Provisional/final conclusion about cause of death of deceased (for preparation of statistical data) *

* Entries made personally by Forensic Medical Examiner.

Transfer of corpse from mortuary freezer to autopsy table is first step of physical exercise and is done by placing tray having corpse parallel to autopsy table and transferring either an arm or leg of deceased on to the table and then rolling rest of the body gently over it.

Corpse personal identification is intimated by police constable escorting dead body and also two of his relatives. Name of police constable with his belt number and names of two relative with their relationship to deceased is entered in appropriate column of autopsy certificate.

Forensic autopsy inclusive investigations would require serial performing of six steps. (Table 11.4)

Table 11.4:

Stages of autopsy examination

- Physical examination and collection of evidence in cloths
- Physical examination of body surfaces and collection of evidence
- Opening of body cavities
- Scrutiny of internal contents (organs) of cavities
- Collection of specimens for further investigations
- Closure and resorting of body

Physical examination and collection of evidence in cloths is done in three steps:

- Preliminary inspection while cloths are still on the body
- Removal of clothes from body of deceased
- Detailed scrutiny of cloths after removal from body

It should be done carefully, avoiding interference or extension in existing cuts, perforations or tears and also possible loss of any foreign material in them. If removal of clothes is hampered due to rigor mortis or there is a possibility that use of force during removal would interfere with above mentioned evidence, clothes should be cut on seams mentioning this fact in the report.

Main objective of this stage is to collect any material from cloths having evidential value. It is done by observing cloths status whether clean, dirty or disturbed like loosened zipper, torn and having cut or bullet hole, which should be encircled and signed with permanent marker for indication and information of investigator and court. If cloths are stained with blood, semen or vomit, they should be preserved. If stains are wet, cloths are air-dried by placing them on hangers. Any foreign material like broken glass pieces, hair, shot charge if present is collected in separate containers.

Physical examination of body surfaces and collection of evidence shall include thorough inspection of body surface with naked eye as well

as with help of magnifying lens and palpation of body parts.

Inspection of body surface is necessary to locate material having evidential value over surface of the body or any abnormality like change in skin color due to disease or postmortem phenomenon and presence of injuries, which are to be noted in proper details. Location of the hypostasis on back of the body surface or any other place can be spotted by pulling upper and lower limbs together upward and to the opposite side.

All body surfaces front, back and both laterals including natural body openings like oral, auricular, nasal, ocular, anal and vulvar and clefts of groin, axillae and natal cleft are carefully inspected. Lateral traction is applied for proper and good exposure of body openings and clefts. Abducting legs with body in supine and prone positions respectively best inspects vulvar and anal openings.

External injuries and their parameters such as shape, size, site, number and relative distribution is noted and measured. Attention should be paid to the degree and extent of soaking of clothes with blood, presence of knife cuts or bullet holes and their relation to the injuries. Existence of cadaveric spasm, defense wound, heaping of epidermis or drying of denuded area should also be carefully noted.

Palpation of body parts will locate any lump or foreign deposit like bullet under the skin that has been missed during inspection. Important sites for presence of the swellings are breast, axillae, groin and neck. When a lump is present, its characteristics about size, consistency and fixation with the skin should be noted. Further, detection of rigor mortis in limbs is noted by flexing them at joints. Extent of force required to bend limbs at the joints will establish degree of rigor mortis. Whole exercise is to establish:

- Physical changes that occur in corpse after death like stage of hypostasis, rigor mortis and putrefaction
- Evidence of mechanical injuries and medical therapy that has been applied externally
- Special evidence of forensic importance such as cadaveric spasm, hesitation cuts or defense wounds.

Opening of the body cavities of cranium, thorax and abdomen is done, without interfering with internal evidence, in two stages depending on the

type of case as to which cavity is to be opened first. Generally abdomen and thorax are first opened together. The body is placed supine with a wooden block under the shoulders to extend the neck. Either of the two primary incisions is applied:

- *Straight incision* in the midline avoiding the umbilicus, which extends from chin to pubic symphysis
- *Y-shaped incision* extending obliquely down from the point just in front of the base of each ear to meet in the midline at the suprasternal notch further following the course taken by the straight incision. This type of incision has the advantage of better exposure of the neck structures.

A modification of Y-shaped incision may be required depending upon extent of exposure of internal contents of neck and thorax. It begins at a point near the acromial end of the clavicle and extends in a curve either above the nipple or below the breast on each side to meet at a point above or below xyphoid process of the sternum depending on whether deceased is male or female. From this point the incision is extended downward in the midline to the symphysis pubis following the course of the straight incision. This incision should not extend into the axillae to prevent leakage after repair. (Fig. 11.8)

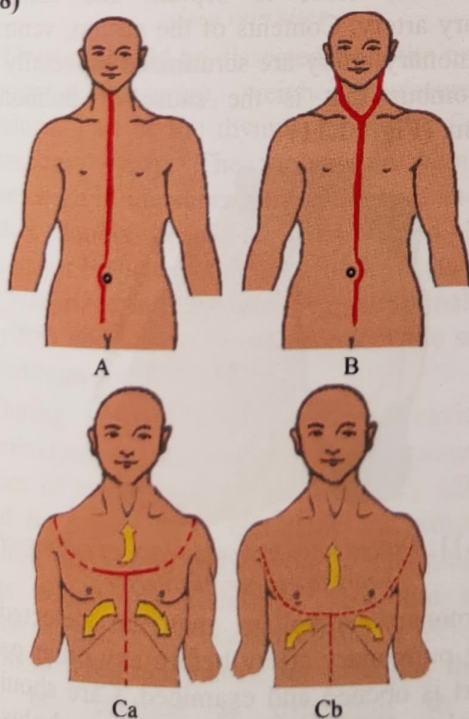


Fig 11.8: Primary postmortem incisions A. Straight B. Y shaped. Ca & Cb. Modified Y shaped with marking of skin reflection above the nipples or below the breasts respectively

After reflecting skin along with muscles from the chest cage, cutting of costal cartilages just medial to the costo-chondral junctions will open the chest cavity. A large, heavy cartilage knife should be used for this purpose and the blade of the knife should be kept parallel with the surface of the body to prevent the point from entering the pleural cavity and puncturing the lung. If the cartilage is calcified, a rib shears must be used. The cutting of the capsular ligament disarticulates the sternoclavicular joint. The first rib is then severed with a rib shears. Starting on one side, the diaphragm is dissected free from the last rib and the triangular piece of chest wall is removed, thus exposing the heart, the superior mediastinum and the pleural cavities.

Structures of the neck may be exposed by further elevation of skin and subcutaneous tissues as far as the arch of the mandible. In suspected interference of neck, layer-wise dissection of the neck muscles should be done and detailed examination of each muscle, thyroid gland, larynx and trachea must also be undertaken prior to removal of tongue. The site and type of any other pathological lesions like fractures of bones of the neck if present may then be spotted and details noted. (Fig. 11.9)

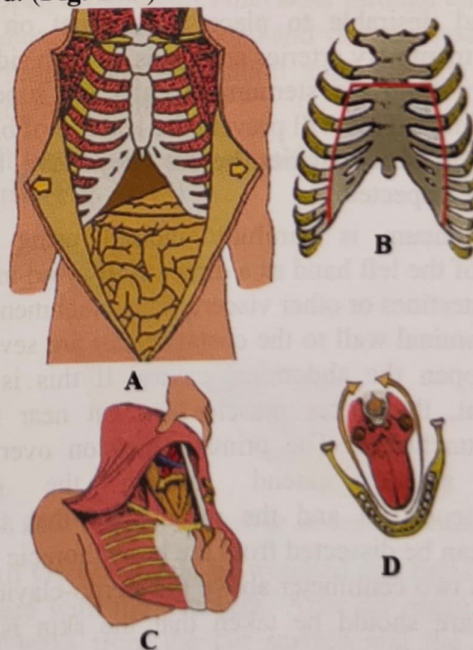


Fig. 11.9: Dissection technique of chest, abdomen and neck. Arrows indicate movement and direction of knife. A. Reflection of skin with muscles from the chest cage and abdomen B. Red lines cutting at costal cartilages for exposure of chest cavity C & D. Dissection and removal of tongue.

Thorax opening is done after testing the presence or absence of pneumo-thorax by making a pocket containing water in the side of the chest after cutting skin along with muscle away from rib cage. An inverted graduated glass cylinder is held over the pocket containing water in the side of the chest, while an intercostals space is stabbed with a scalpel below the water level to permit the escape of air in to the cylinder. The scalpel should be twisted to ensure adequate opening of the puncture site. It will show gas bubbles replacing the water in the cylinder. (Fig 11.10)

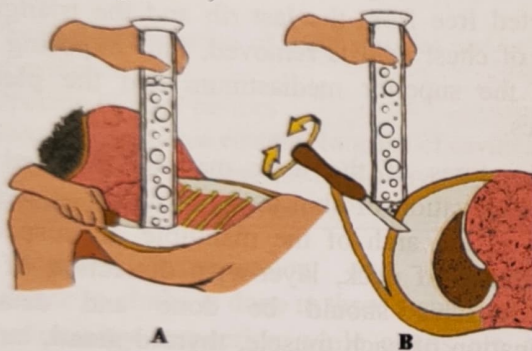


Fig.11.10: Technique to demonstrate presence or absence of pneumo-thorax

Character of the tissue in the anterior mediastinum and the size and consistency of the lymph nodes in this region should be noted. It will be found desirable to place a hemostat on the internal mammary arteries and veins on each side of they turn from the sternum to enter the superior mediastinum. This will prevent the leakage of blood into the pleural cavities before they have been carefully inspected.

Peritoneum is carefully incised using two fingers of the left hand as a director, to avoid injury to the intestines or other viscera. The attachments of the abdominal wall to the costal border are severed to lay open the abdominal cavity. If this is not sufficient, the rectus muscles are cut near their pubic attachment. The primary incision over the thorax should extend through the skin, subcutaneous fat and the muscle, so that these tissues can be dissected from the bony thoracic wall as far as two centimeter above the sterno-clavicular joint. Care should be taken that the skin is not punctured as the tissues are elevated.

Scrutiny of internal contents of cavities and vital systems starts with the inspection of the pleural cavities for the presence or absence of any fluid and adhesions in them. If there are adhesions they should not be broken, rather the parietal layer

of the pleura elevated from the underlying inter-costal muscles and ribs and taken with the lung. If the adhesions are broken, the adjacent lung tissue is frequently torn.

Pericardial cavity should be opened carefully and the amount of fluid, the condition of the surfaces, and the presence of any adhesions should be noted. In the case of hemo-pericardium due to rupture of left ventricle or of the intra-pericardial part of aorta, the blood should be collected and measured. It may amount to as much as 500 ml. The origin of hemorrhage should be established before the heart is removed otherwise the source of the blood might be lost. The heart may be removed unopened or the right side may be opened before removal.

For examination of the heart, the pericardial sac is incised and filled with water and the above technique for testing air in the pleural cavity is repeated by placing inverted graduated cylinder containing water over the right side of the heart and scalpel punctures the heart to enable the gas within the ventricle to replace water in the cylinder.

A cut is made in the right atrium, continued through the tricuspid valve along the inferior part of right ventricle then through the anterior wall of the right ventricle close to septum and into the pulmonary artery. Contents of the atrium, ventricle and pulmonary artery are scrutinized especially for any thrombus that is the cause of pulmonary embolism. (Fig. 11.11)

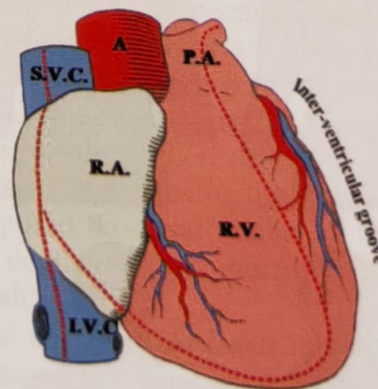


Fig. 11.11: Dotted lines indicate place of cutting of the heart to expose its interior

Pulmonary embolism may be detected by opening pulmonary artery before any other part of the heart is opened and examined. Care should be exercised to differentiate between an embolus that originates from deep veins of the leg from those formed by post-mortem clotting in stagnant blood. An embolus is firm, has transverse ridges, often

coiled upon itself and generally of the size of femoral vein. Postmortem clots, which form after death in stagnant blood, are soft, smooth, shiny and purple or yellow. When yellow in color, it is called chicken fat clot. The confirmation of origin of such thrombi from deep veins of the leg can be confirmed by exploring the calf muscles, transversely incising the belly and noticing a firm solidly structured thrombi popping out as sausages from the transected vein. The postmortem clot being flabby does not pop out and instead bends under the influence of the gravity. (Fig. 11.12)

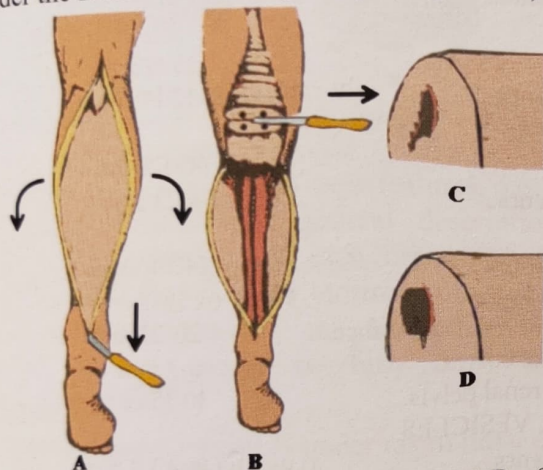


Fig. 11.12: Transecting exposure stages A & B of calf muscles C & D to differentiating features at transected deep vein sites

Thymus should be dissected from the tissues of superior mediastinum, weighed, measured and examined. Part of the thymus should be fixed for microscopic study. The innominate vein as it crosses high in the superior mediastinum should be isolated, doubly ligated and divided, so that the three major branches of the arch of the aorta may be fully visualized in a dry field. Any abnormalities in the lymph nodes or other structures of the superior mediastinum should be noted.

During inspection of peritoneal cavity and abdominal organs, amount of fluid, character of the surfaces of organs and presence of any adhesions should be noted. Size, character and position of omentum may yield information concerning focal lesions within the abdomen. Size and relative position of each of the viscera should be recorded in relation to fixed landmarks; for example, the liver might be recorded as extending so many centimeters below the costal margin in midclavicular line.

In any instance in which there is an increased amount of fluid in the serous cavities, 50 cc. should

be collected in a clean dry vessel to determine the specific gravity and the character of the cells in the centrifuged sediment of the fluid. Cultures and smears should be made if indicated.

Two techniques namely **organ-by-organ method** and **visceration method** for the removal of viscera out of the body cavities are available. Each method may be modified to meet special conditions and experience of Forensic Medical Examiner. In medico-legal practice, organ-by-organ method of dissection to remove the organ should be adopted keeping in mind two principles:

- No organ is to be separated from a connecting structure until the intervening tissue has been dissected and examined for example renal arteries and veins, their ostia and ureters should be examined before kidneys are removed from the body. Similarly, ampulla of Vater, bile duct, gall bladder, portal vein and hepatic artery should be examined before the liver is separated from the stomach and duodenum. The mesentery, mesenteric arteries and veins should be explored before the intestine is separated from them.
- Primary incisions in each organ should be so placed as to:
 - Expose the largest possible surface
 - Open the structures that enter through the hilum
 - Make visible the ductal and vascular systems
 - Preserve the orientation and relations of the organ as a whole

All further incisions should be placed parallel to the first. (Fig. 11.13)



Fig. 11.13: Incision for cutting an organ to examine it

All viscera should be weighed and measured to compare with the averages. After an organ is cut, blood leaks from the cut surface and the weight may be changed by as much as 20 %. In general, weight, greatest length, greatest breadth of the organ should be recorded. In some organs special measurements are indicated for example, the circumference of the valvular rings and the thickness of the walls of the heart and the thickness

of the cortex and of the entire substance of the kidney.

Size and weight of each organ varies according to age, stature, and body weight, but figures given in the chart represent range of an average normal

adult male between 20 and 30 years of age. Size and weight of thyroid varies geographically, but normal thyroid should not exceed 40gm. (Chart. 11.1 & Fig.11.14)

BRAIN:		LUNGS	
Weight...	1250-1440gm	Weight of right lung...	375-550 gm
Sagittal diameter...	16-17 cm	Weight of left lung.....	325-450 gm
Vertical diameter...	12-13 cm	LIVER	
SPINAL CORD		Weight....	1500-1700 gm
Length....	45 cm	Measurements...	25-30 x 19-21x 6-9cm
Weight....	27-28 gm	SPLEEN	
Frontal idameters:		Weight....	125-175 gm
Cervical....	13-14 mm	Measurements...	3-4x8-9x12-14 cm
Thoracic....	10 mm	PANCEREAS	
Lumbar.....	12 mm	Weight....	90-120 gm
Sagittal diameters:		Measurements...	3.8 x 4.5 x 23 cm
Cervical....	9 mm	KIDNEYS	
Thoracic....	8 mm	Weight of each....	140-160 gm
Lumbar.....	9 mm	Measurements...	3-4x5-6x 11-12 cm
PITUTIARY		Thickness of renal substance....	20-23 mm
Weight.....	610 mg	Thickness of cortex...	6-7 mm
PINEAL		Volume of renal pelvis...	10-15 cc
Weight.....	140-170 gm	SEMINAL VESICLES	
PAROTID GLAND		Measurements...	0.9x 1.6x1.8x4.1-4.5 cm
Weight.....	About 30 gm	TESTIS AND EPIDIDYMUS	
SUBMAXILLARY GLAND		Weight together...	17-27 gm
Weight.....	About 17 gm	Measurements of testis...	2-2.7x2.5-3.5x4-5 cm
THYMTJS		PROSTATE	
Weight.....	19-23 gm	Weight....	14-16 gm
HEART		Measurements...	2.7x3.6x 1.9 cm
Weight....	275-325 gm	ADRENALS	
Thickness of auricles....	1-2 mm	Weight of each...	5-7 gm
Thickness of left ventricle...	8-10 mm	Measurements....	0.5 x 2.5-3.5 x 4-5 cm
Thickness of right ventricle...	2-3 mm	GASTROINTESTINAL TRACT	
Circumference of mitral ring...	10 cm	Length of esophagus,	
Circumference of aortic ring...	7.5 cm	cricoid to cardia...	25 cm
Circumference of pulmonic ring...	8.5 cm	Vertical length of stomach...	25-30 cm
Circumference of tricuspid ring...	12 cm	Length of duodenum.....	30 cm
PULMONARY ARTERY		Length of small intestine...	550-660 cm
Circumference.....	8 cm	Length of large intestine...	150-170 cm
AORTA		UTERUS	
Circumference of ascending aorta...	7.5 cm	Weight in nullipara....	40-60 gm
Circumference of descending aorta...	4.5-6 cm	Weight after a pregnancy....	75-125 gm
Circumference of abdominal aorta...	3.5-4.5 cm	OVARIES	
THYROID		Weight of one...	8-12 gm
Measurements.....	1.5-2.5 x 3-4 x 4-7		
PARATHYROID			
Weight....	115-130 gm for 4		

Chart. 11.1: weight and measurement scale of body organs

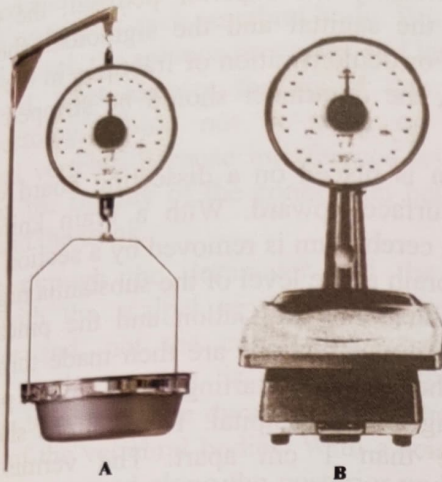


Fig. 11.14: Organ scale with weight display **A.** Wall and **B.** Table mounted

While examining organ and their features, i.e. size, shape, color, consistency, general description of capsule and cut surface of each organ should be noted. All departure from normal position and relation and all pathological lesions including traumatic damage should be fully described, if injuries are present.

Pelvic organs removal is under taken next, either as a part or all of them together. It would require extension of incision in the abdominal wall caudally over the symphysis pubis to the crest of labia majora or base of the penis including them in a circular fashion. With large cartilage knife, the symphysis pubis is divided and the legs are pulled outward, exposing the uro-genital triangle. In case of female's ovaries, tubes and uterus are examined first in situ and then cut from their attachments in the floor of the pelvis to remove them. Similarly, in case of male, prostate gland and the external genitalia are examined first and then removed from their attachments. (Fig. 11.15)

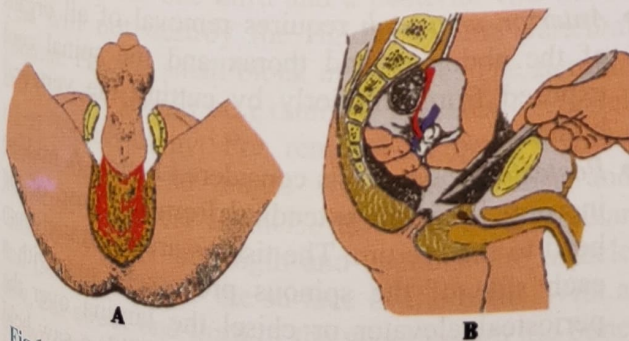


Fig 11.15: Dissection technique of genitalia **A.** Prostate gland and external genitalia in male **B.** Ovaries, tubes and uterus in female are removed together

Cranial cavity is opened after careful examination of the whole scalp for the presence or absence of any injury. Head and neck supports, made either of hard-rubber, wood or stainless steel are used for positioning of dead body by placing head-rest and neck support under them respectively. (Fig. 11.16)

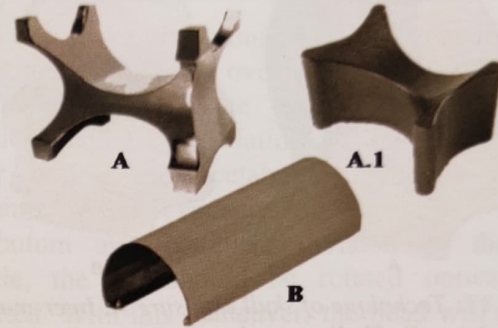


Fig. 11.16: **A. & A.1** Head rest and **B.** Neck support

Skull should be exposed by an inter-mastoid incision of the scalp extending over the vertex. The blade of the scalpel is best turned outward in order to prevent cutting of the hair. If an individual is bald, this incision should be placed as far back as possible at the posterior extremity of the parietal bosses. The scalp is reflected both forward anteriorly and backward posteriorly, taking care that the skin of the forehead is not perforated by knife. All tissues under the scalp are cleanly cut from the bone except for the temporal muscles and fascia. Anterior reflection should be carried to a point 1.5 cm. above the supra-orbital ridge.

Next step is separation of skullcap by saw-cut in anterior half of the cranial bones, which should extend from deepest point of one temporal fossa to the corresponding point in the opposite temporal fossa. It should run from behind the external auditory canal to the frontal bone, going parallel to the supra-orbital ridge and not less than 4-cm. superior to them. With a scalpel cut the temporal muscle and fascia on each side along this line and with a blunt instrument separate the tissues from the squamous portion of the temporal bone along this incision. The saw-cut in the posterior half of the cranial bones should be composed of two parts, meeting at an angle in the midline. On each side, the cut should extend from the lower end of the anterior cut, backward and upward over the occipital bone to meet in the midline. The angle formed by the anterior and posterior incisions should be from 100 to 120 degrees and that between the posterior incisions from 120 to 150 degrees. With a fine-tooth saw, cut through all of the outer and

greater part of inner table and with a chisel and hammer break the remaining few parts of inner table. The fracture line so produced will serve to anchor the skullcap more securely for restoration of the body. (Fig. 11.17)

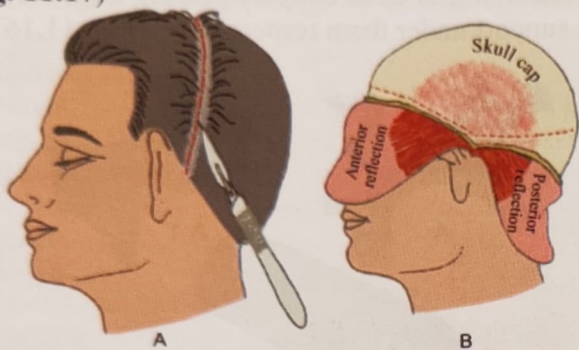


Fig 11.17: Technique of skull exposure **A.** Inter-mastoid incision. **B.** Skullcap and scalp flaps reflections

Calvarium is removed separating it from the underlying duramater by blunt dissection. The superior longitudinal sinus is opened with a scalpel, and then the duramater is cut along the saw-cuts in the bone with a scissors. The duramater reflected toward midline, and cerebral veins on each side are divided with a scalpel or by blunt dissection. The size and appearance of arachnoidal granulations in this region are noted. Anterior attachment of the duramater within the great cerebral fissure is cut with a scissor. Falx cerebri is pulled posteriorly, exposing full surface of both cerebral hemisphere from floor of the anterior cranial fossa, and with a blunt instrument, attachments are freed from olfactory nerves to cribriform plate of the ethmoid bone. On further retraction of the brain, cut the optic nerve, the carotid arteries (leaving not less than 4 mm. within the cranial cavity for ligation), the stalk of the hypophysis, and the third, fourth, fifth, sixth and seventh nerves on each side. As these structures are successively cut, take great care to support the brain in the left hand. With a knife, cut the tentorium cerebelli along its attachment to the superior border of the petrous temporal bone on each side. The posterior cranial fossa is thus exposed. Divide the remaining cranial nerves on each side and cut across the vertebral artery and the lower end of the medulla as far caudally as possible. Now support the brain in the right hand and with the fingers of the left reach into the posterior cranial fossa and lift the cerebellum, at the same time rotating the cerebral hemispheres posteriorly and upward. The brain should slip easily from the cranial cavity. Examine the external appearance of the brain. The dural

sinuses, notably the superior petrosal, the inferior petrosal, the sagittal and the sigmoidal should be opened. For demonstration of fractures in the base of the skull, the duramater should be stripped off the bone.

Brain is placed on a dissecting board with the ventral surface upward. With a brain knife, brain stem and cerebellum is removed by a section through the interbrain at the level of the substantia nigra. This exposes the veins of Gallon and the pincal body. Parallel coronal sections are then made through the cerebral hemispheres starting at the frontal poles and continuing to the occipital. The sections should not be more than 1 cm apart. The vermis of the cerebellum is split sagittally and the two halves of the cerebellum removed from the pons by division of the cerebellar peduncles. Each half of the cerebellum is then sectioned into thin blocks in a plane parallel to the original section of the vermis. The inter-brain, pons and medulla are cut in parallel cross sections at 5 to 7 mm intervals. (Fig. 11.18)

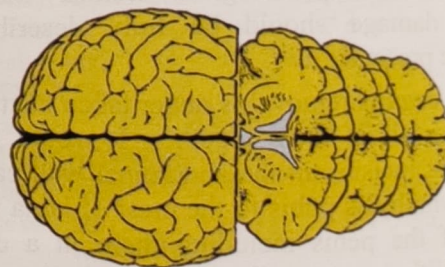


Fig 11.18: Sectioning of brain

The procedure is greatly expedited if each freshly sectioned surface is pressed firmly against a piece of glass before the next cut is made. Flooding the knife with 95 percent alcohol can prevent stickiness of the knife as well as of the tissues.

Vertebral column and spinal cord examination can be done through anterior or posterior approach:

- **Anterior approach** requires removal of all organs of the abdomen and thorax and the spinal cord exposed from anteriorly by cutting the vertebral bodies.
- **Posterior approach** is considered better. A midline incision is given, extending from the base of the head to the sacrum. The tissues are separated from each side of the spinous processes, and with a periosteal elevator or chisel the lamina over the region to be opened are exposed. With a saw held as close to the spinous processes as possible and directly perpendicular, the lamina is sawn through. If the saw is tilted laterally the canal will not be

entered and the saw will continue through the bone of the pedicle of each vertebral body. With a wide-edged chisel, the spinous processes and laminae are removed. This exposes the spinal duramater. A laminectomy should not be done on the first cervical vertebra because interference with it will destroy the rigidity of the connection between the head and the trunk.

Cut through the duramater and the cord or nerves with the scalpel at the lowest point. The duramater and, not the cord, is grasped with a forceps, gentle traction is applied before sharp dissection to separate the duramater from the anterior surfaces of the vertebral bodies. With a scissors, the duramater is opened along the posterior and anterior midlines. The cut surface is examined by multiple cross sections made with a knife wet with alcohol. For fixation, it should be suspended in a tall jar filled with 10% formalin. (Fig 11.19)

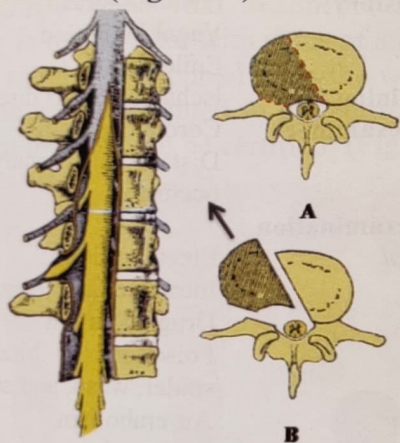


Fig 11.19: Technique for exposure of spinal cord

Bones, joints and bone marrow examination is done after removal of all the viscera from the abdomen and thorax. The lumbar vertebrae should be opened by a saw-cut, separating the vertebral bodies into an anterior one-third and a posterior two-thirds. This will not destroy the rigidity of the vertebral column. Place a small block in fixative. The sternum and the ribs should be examined and small samples taken for histology. For removal of bone marrow from long tubular bones like femur, tibia and humerus, it is best to incise the skin in a circular direction 10 cm. in length and separate the muscle and fascia to expose the surface of the bone. With a saw, cut about one-third of the way through the bone at two points about 2 cm. apart. With a chisel and hammer remove the cap of cortical bone. An adequate amount of bone marrow may be secured through this opening. (Fig. 11.20)

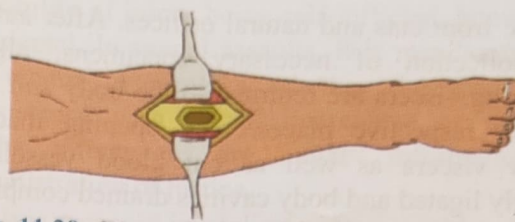


Fig. 11.20: Dissection and collection of bone marrow

If one of the long tubular bones is to be removed, a longitudinal incision over the entire length of the bone is made and the joints at each end are disarticulated. Disarticulation of the head of the femur within the acetabulum presents peculiar problems. After exposure of the region of the acetabulum and complete division of the joint capsule, the leg should be rotated outward and adducted. With this maneuver, the head will roll out of the acetabulum and the femur may then be easily removed. Exposure of the knee joint is best accomplished through a U-shaped incision, the base of the U passing through the skin directly over the patellar tendon when the leg is in an extended position. The incision is extended through the patellar tendon and the patella, rectus femoris muscle and surrounding tissues elevated for a distance of some ten to fifteen cm. The lower leg is now flexed on the thigh, the articular surfaces of both the femur and the tibia will be brought into full view and may be examined. If any of the long bones are completely removed, the rigidity of the body must be restored by the judicious use of wood and plaster. If an entire bone is to be removed, have this part of the body embalmed before the circulation is interrupted by the dissection.

Tissues of the arm and hand can be examined following the cardinal principle that the skin of the face, neck, arms and hands are not to be incised. The structures within the arm or hand must be examined by making a complete circular incision through the skin of the upper arm, and inverting and rolling the skin downward until the region to be examined is reached. (Fig 11.21)

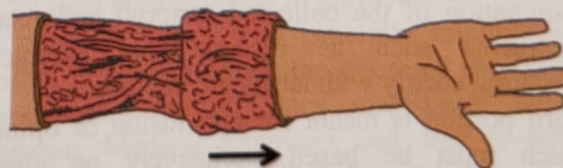


Fig. 11.21: Dissection to de-glove a portion of limb

Closure and restoration of the body is guided by two principles of meticulous reconstruction of normal body anatomy and ensuring absence of

leakage from cuts and natural orifices. After autopsy and collection of necessary specimens, all the remaining viscera are returned to the body and fixed in their respective places. Any opening made in hollow viscera as well as cut blood vessels are securely ligated and body cavities drained completely of any fluid including blood. In case of extensive collection of abdominal viscera, the free space is packed with cotton to restore normal abdominal contour. In cranial cavity, carotid and vertebral arteries are ligated and foramen magnum plugged tightly with cotton to prevent leakage of the cerebrospinal fluid.

All primary incisions should be closed tightly with overlapping of the skin edges to ensure freedom from leakage during transit. Anal and genitourinary orifices should also be closed securely by sutures. Any unsightly defects in the exposed parts of the body should be reconstructed properly paying special attention to the face. In case of removal of a long bone, wooden prosthesis should be placed for reconstruction of structural integrity of the limb,

Forensic Autopsy certificate is prepared keeping in mind its specific objective, whether medical or forensic. It should also be kept in mind that this document is to be perused by non-medical people like law enforcement, lawyers and judges. The language used should be simple, avoiding technical terms especially in the portion of opinion. It consists of three portions:

- First portion contains deceased's bio-data, name, number and police station of escorting constable and name and relationship of two persons who verified his personal identity. In case where identifying relatives are not available, morphological data of the corpse regarding its personal identity should be mentioned.
- Second portion should include all the external and internal findings in respect of trauma or intoxication elicited during gross examination, results of histological and toxicological examination of the collected material and related documents such as receipts and dispatches indicating clearly with labels are enclosed.
- Third portion is meant for conclusion or opinion, which must be based exclusively on elicited medical facts recorded in the second part of the certificate. It comprises of cause and manner of death, fatal and postmortem period, being essential inferences.

A thorough autopsy nearly always succeeds in revealing the cause of death. There are very rare occasions, however, when the exercise fails to establish the cause of death due to certain biochemical disturbances, which the current state of knowledge cannot identify. Medical examiner should admit and explain this fact with ease to other concerned individuals. He would be justified to certify cause of death as *unknown or undetermined*. Such an autopsy is called **negative autopsy**. Deaths from severe emotional disturbances, especially vasovagal shock and fright are true negative autopsies. Besides, there are other causes for an autopsy to be negative. (Table 11.5)

Table 11.5:

Causes of negative autopsy

Cause	Examples
Autopsy without adequate history	Anaphylactic shock Pneumothorax Vagal inhibition Epilepsy
Lack of training of medical examiner	Ischaemic heart disease Coronary spasm Distal coronary artery occlusion
Lapses in examination	
i) <i>External</i>	Electrocution Intracardiac injection Drug addiction Poisonous bites (snake, spider, wasp, and scorpion)
ii) <i>Internal</i>	Air embolism Pneumothorax Coronary spasm Distal coronary artery occlusion
iii) <i>Laboratory</i>	Faulty or negative results (with no contribution for determination of cause of death)
a) <i>Histological</i>	
b) <i>Toxicological</i>	
Insignificant trauma or disease	Concussion Fat and air embolism Delirium tremens Polyarteritis nodosa Pathology of SA/AV node and bundle of His Myocarditis
Trauma at concealed sites	Firearm injury in nostrils, ear, palate, Atlanto-occipital and atlano-axial joint dislocation with spinal cord injury

Documentation of elicited finding during forensic autopsy, being an integral part of the protocol, is mandatory in medico-legal practice. Status of the dead body like fresh or under decomposition, findings such as injuries in cases of trauma and signs/ symptoms of intoxication and specific characteristics surrounding the case have to be documented as *written record*, supported with *markings on sketches* and *photographs*, wherever necessary. Close-up pictures of injuries, other damages and presence of staining of clothes followed by full view of clothed and unclothed body are essential requirement. Trajectory or path of a firearm wound should be photographed by placing an iron rod in the track. Fractures should be recorded on X-rays. The certificate should also include results of clinical investigations and reports on collected material and all other relevant documents must be placed in order indicated by labels. In case the victim is admitted into the hospital, treatment notes, duration of his stay in the hospital with dates of admission and discharge should be obtained from the ward and this information be incorporated in the certificate so that full facts of the case can be certified. (Fig 11.22)

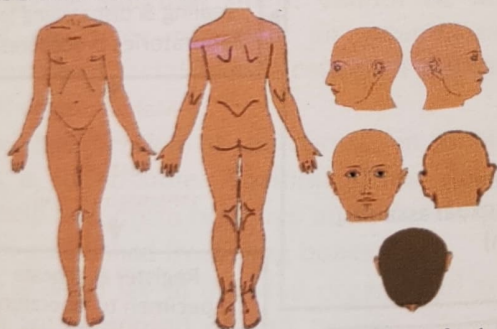


Fig. 11.22: Sketches for markings sites of injuries

Formulation of opinion/conclusion is drawn on the observed and above recorded facts. It is emphasized that the opinion should be framed dispassionately without entertaining sentiments, sympathy or personal theory. It should not be influenced from outside. In case of difficulty or inability to elicit or interpret a finding and frame opinion about it, the matter should immediately be referred to trained and qualified colleague in the specialty for advice. Delay in seeking advice is detrimental and may add limitations to final evaluation due to masking effect of onset of inflammatory in living cases and start of decomposition in cases of dead.

In medico-legal practice conclusive comments are about the nature of the causative agent along with estimation of time lapsed, gravity of damage and

possibility of injury being self-inflicted, homicidal or accidental. In sexual assaults, it is mandatory to put on record in remarks whether the findings are consistence with sexual intercourse or otherwise. Such inferences are vital information for administration of justice.

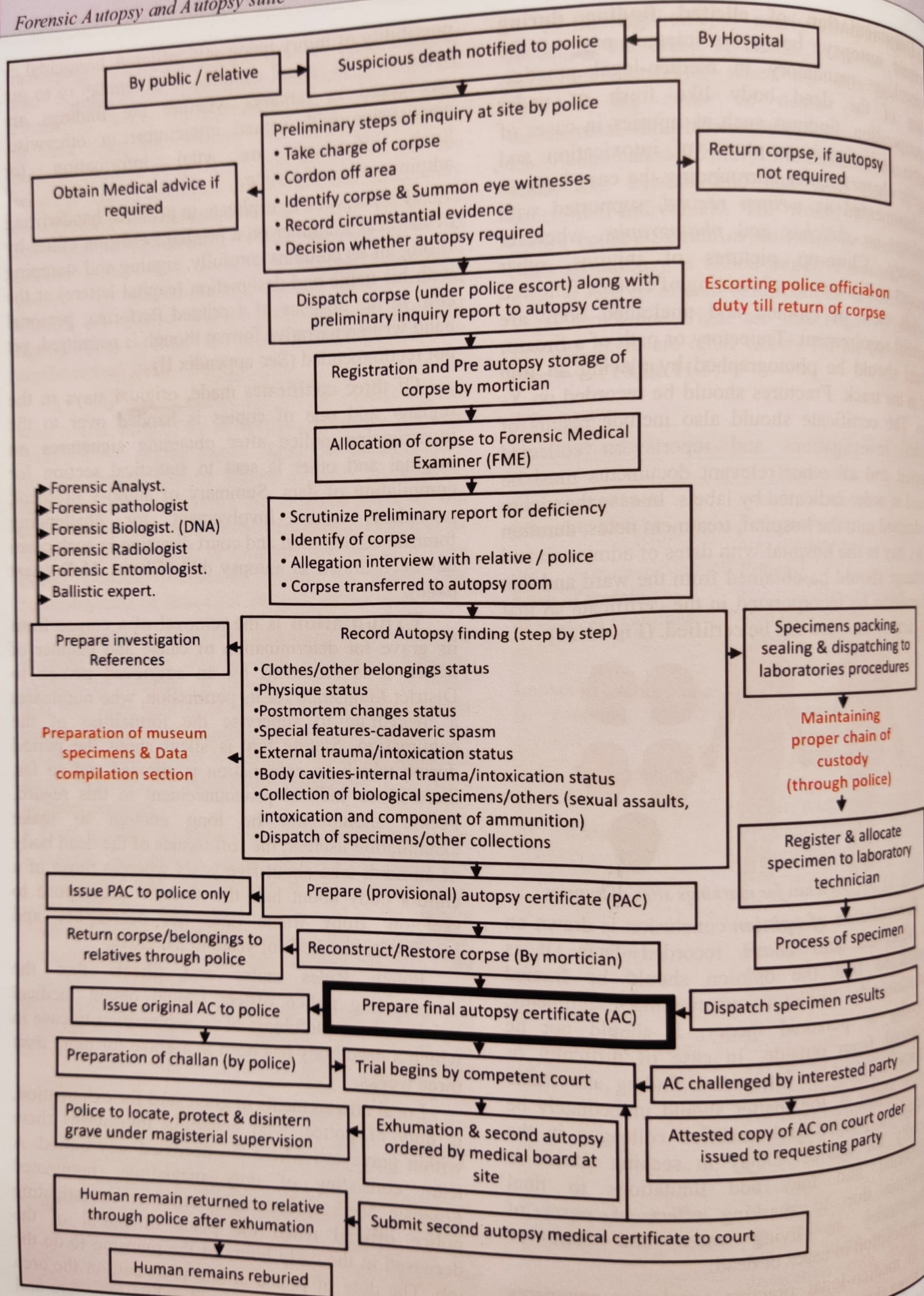
It is prepared in triplicate in personal handwriting of medical examiner on a printed Performa either by filling all its columns carefully, signing and stamping with his name and designation (capital letters) at the end. In the absence of a printed Performa, personal hand written narrative format though is permitted, yet not recommended (See appendix II)

Of three certificates made, original stays in the register and one of copies is handed over to the investigating police after obtaining signatures on original and other is sent to statistical section for compilation of data. Summary of autopsy protocol, procedure, court involvement for challenging forensic certification and court direction in such cases has been drawn in autopsy drill (**Chart. 11.2**) (next page).

Exhumation is the removal of a corpse from its grave for determination of cause and manner of death. It is requested by an aggrieved person to District Magistrate for its permission, who nominates a magistrate to supervise the formalities of the exhumation. Statute law is silent about the period during which an exhumation is allowed and so far, there is no judicial pronouncement in this regard. Period should not be long enough to make examination useless; the soft tissues of the dead body of an adult take about five years whereas those of a child's body about half this time to decompose to skeleton. Bony frame does not decompose and persists for hundreds of years in the grave.

Police Rules states and directs that the investigating police officer should obtain medical opinion about usefulness of an exhumation in case in which a dead body has been in a grave for more than three weeks.

Local arrangements in graveyard for exhumation, is duty of police, who generally improvises them within graveyard where the deceased stay buried. A team consisting of duty magistrate, nominated Forensic Medical Examiner and area investigating police official reach the place of burial of the deceased in the early hours of the morning to do the job. The duty of police at site is to cordon the area and protects the grave to avoid public exposure and interference.



The magistrate prior to digging of the grave directs the relatives of the deceased and persons responsible for burial to identify the grave and then he orders disinterment. After opening of grave, it is left open for some time to allow the foul gases to escape. The corpse is lifted and placed on an improvised platform usually a wooden board meant for final wash of the dead body. (Photo 11.3)



Photo 11.3: Lifted corpse out of grave in advance stage of decomposition along with coffin

Such corpses generally are in different stages of putrefaction. Autopsy after disinterment is an arduous and time consuming job. Excuse that examination at site is difficult or not possible, because of condition of the corpse and foul smell, cannot be accepted. Desired objectives of such an examination are conformation of facial identification of deceased, its cause of death:

- *Facial identification* of the corpse, in most of the cases, is not possible. Anatomical and dental data may help to confirm both age and sex. Height may also be established from long bones.
- *Cause of death* lay in the vital organs and systems, which are composed of soft tissues. The success about the findings will depend upon the condition of the corpse. A thorough search should be made. Sampling should be as much as possible including earth and wood of the coffin. Earth samples are collected from above, beneath and both sides of the coffin and a control specimen from a remote place in the cemetery away from the grave. If the coffin has fluid, it should also be collected.

Results of exhumation depend on duration of the time elapsed since death and greater the time passed; fewer are the chances for a rewarding exercise. The findings in most cases are not as clear and accurate as those obtained in a fresh case. When the soft tissues have been adversely affected by advanced decomposition, no definite opinion about the cause of an injury and whether it is ante-mortem or otherwise can be expressed with certainty. Further, the use of embalming agent, preservatives or deodorants at the

time of burial may interfere with analytical results. Every case has to be dealt with on its own merits. The findings of a break or a cut with a sharp weapon or a bullet hole in the bone including skull have only a corroborative value. Worse still will be the findings of a case, which has already been mutilated by an earlier autopsy. Exhumation, many months after the burial, is usually a futile exercise, except only in a poisoning case.

CHAPTER 12

12. Death and Related Issues

Thanatology is scientific study of phenomena of death, which ends continuity of individual's life and personality. Life rests upon full integration of three vital systems of respiration, circulation and innervation called **tripod of life**. Persistent stoppage of any one vital system shall produce stoppage of other two systems eventually precipitating death. There are, therefore, three modes of dying irrespective of mechanism, cause and manner of death. (Fig. 12.1 & Table 12.1)

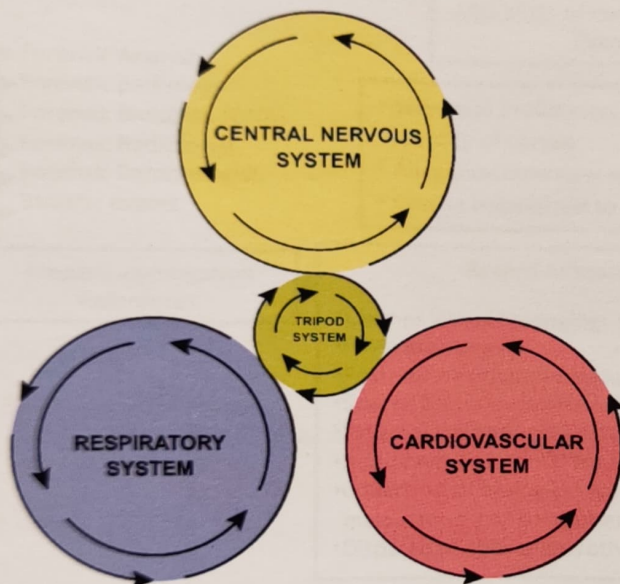


Fig. 12.1: Tripod of life resting upon integration of three vital systems

Table 12.1:

Modes of dying	i. Asphyxia (stoppage of respiration) ii. Syncope (stoppage of circulation) iii. Coma* (stoppage of innervation)
Causes of dying	i. Disease ii. Injury iii. Intoxication
Mechanism of dying	Chain of physiology/biochemistry changes in body precipitating death
Manner of dying	Circumstances surrounding death
	i. Natural (disease) ii. Unnatural (other than disease) a. Accident b. Homicide c. Suicide

* Term coma has been adopted to represent brain death

Previous common parlance concept of death that it takes place at a definite moment of time holds true only as far as **systemic**, also called **clinical death**. In

addition there is **cellular** or **organic death**, which chiefly occurs due to cell anoxia depending upon ability of tissue to withstand it. Brain tissue is the most vulnerable to anoxia and dies first, followed by death of other tissues. Fact is that an individual's process of dying is in bits and pieces, spread over a period of time starting with systemic death and followed by death of various organs. Biologically death of various organs takes place at different time depending upon their viability period. (Table 12.2)

Table 12.2:

Tissues viability period

Tissue	Period
Nervous tissue	A few minutes
Muscular tissue	6 hours
Cornea	6 hours
Skin	12 hours

Suspended animation, also called **apparent death** in living being occurs when body vital processes are depressed to the minimum compatible with life, but clinically not perceptible. For all intents and purposes, he looks and behaves like a corpse. Some will recover from this state and others die. Phenomenon exists in both human beings and animals during hibernation. Further it is recorded that human beings have this ability and can acquire such a state voluntarily. Examples are many Saints in Asia. Reorganization and diagnosis of suspended animation is important due to its occurrence during electrocution, drowning, hypothermia and acute intoxication with strong hypnotic.

Death certification since earlier times has been duty of the medical practitioner. He has been certifying death basing on criteria of complete and persistent stoppage of both respiration and circulation over a continuous period of several minutes. These criteria remained the hallmark of death certification, but this simple statement no more holds true and are inadequate.

Shapiro says death is an abstract noun, which may be meaningful to lawyers and priests but is very inadequate as a biological description. He makes a definite distinction between the properties of the whole person and those of his component parts. **Muller** claims that dying is a process and not a moment of time.

Developments in medicine have complicated the situation of diagnosis of death. It is now possible to

stop both respiration and circulation for some time by lowering of body temperature and then on re-warming restart them. Encephalitis disease and acute and severe poisoning by strong hypnotic and tranquilizer produce similar states where it becomes extremely difficult to tell whether respiration and circulation have ceased or not. Further diagnostic aids like ECG, EEG shows no electrical activity in above states and modern resuscitative techniques have made it possible to maintain both circulation and respiration for indefinite periods in cases that have no claim of life. This has led to the belief that stoppage of respiration and circulation alone does not constitute death, which perhaps is non-return of these systems after their stoppage. It is a negative concept and is difficult to diagnose.

Prof. F. Camps has firm view that effect of lack of oxygen on brain during the period of stoppage of respiration is important. It depends upon degree of actual impact on function of brain to know, "*whether brain still functions and is capable of thought*". It introduced concept of irreversible brain damage i.e. **brain death** in clinical diagnosis of death.

Brain death now has been formally proclaimed in Western countries. Most countries in Asia though accept it medically, yet at present still lack its legal recognition. The belief, that when brain death is accurately diagnosed, life will not return to the patient even with continuous cardiopulmonary support is a certainty. The critical point involved in this whole issue is what actually constitutes adequate proof of brain death.

Two codes of guideline in this respect are available in UK and US. Despite some differences, both acknowledge that brain death should be recognized only when following three criteria are fulfilled:

- Whilst on a ventilator patient is comatose and has a positive diagnosis of cause of coma preferably intoxication, metabolic and hypothermia, excluding endocrine disturbances as causes of coma
- Complete loss of brainstem function has occurred and brainstem reflexes like pupil, corneal, facial, oculo-cephalic and oculo-vestibular should all be absent
- Patient should remain apnoic after disconnection from ventilator, long enough to ensure that arterial carbon dioxide tension is above 8 kPa, which is level capable of driving respiratory center

When properties of whole patient are irreversibly lost following brain death, he should be taken as **legally dead**. Cells and tissues continue to remain viable for a variable time after systemic death, which occurs earlier than death of organs. There should be no objection to preservation and removal of properties of the living matter in component parts for the purposes of organ transplantation.

Decision that death has occurred should be based on the principle that clinical interest of an individual does not lie in the preservation of isolated cells or organs, but in the fate of the individual as a whole. Time of death of various cells or organs is less important and should be subordinate to systemic death. Death certification by medical practitioner therefore, must be based on clinical judgment fulfilling certain essential criteria. The most helpful aid in diagnosis of death is EEG. (**Table 12.3**)

Table 12.3:

Clinical judgment criteria for certification of death and their significance

Criteria	Significance
Bilateral fixed dilation of pupils	Essential
Complete absence of reflexes both natural and to profound pain	Essential
Complete absence of respiration	Essential
Falling BP needing increasing vaso-constrictive drugs	Additional
Flat EEG for at least six hours*	Additional

* Excluding cases of hypothermia/drug over dosage

World Medical Association has concluded that presently, it is impossible to give a precise definition of death and decision whether death has occurred should continue to be a clinical decision to be made by physician. When transplant surgery is involved, death should be certified by at least two physicians in no way connected with transplant team.

Postmortem phenomena are final changes in state of corpse sooner all three vital systems of the body fail and death takes over. The process is combination of multiple actions like decay; decomposition and rotting inflicted on the dead body. These actions bring changes both in body physical shape and chemical in body fluids converting their composition. Soft tissues affected are body covering including skin, muscles of extremities, organs within cavities of cranium and orbit, chest and abdomen. Hard structures like bones, nails and hair are immune

from these changes as they do not putrefy. These changes have an order of onset and rate of progression till its completion, which can be utilized to approximate time since death. Eventually all soft tissues and body fluids gets converted into foul smelling liquid and gases, which drain in soil and escape in air. Changes manifest separately in soft tissues and body fluids as **physical changes** and **chemical changes** respectively.

Postmortem phenomenon is a continuous process and its division into compartments of physical and chemical changes is only to understand sequence of events. Soft tissue physical changes are **immediate, early, late and very late physical changes**.

Immediate physical changes are due to loss of tripod of life precipitating muscular flaccidity more correctly primary flaccidity along with loss of reflexes, asystole and stoppage of chest movement. Primary flaccidity is manifested in a corpse as dropping of lower jaw and looseness of limb muscles. Other physical changes i.e. asystole and stoppage of respiration are due to absence of heart and lung function respectively. They take place simultaneously and are manifested in a corpse as lack of pulse and respiratory movement of chest.

Early physical changes are due to stoppage of vital tissue responses and they are **fall of body temperature, hypostasis, rigor mortis and changes in eye ball**.

Fall of body temperature is a passive parameter. Maintenance of a constant body temperature at 98.4 Fahrenheit in living state is result of an active vital process of *temperature regulation* by which heat losses from all routes in an individual are kept in equilibrium with heat produced according to the metabolic state of the person. This vital response ends with the onset of death and dead body starts to lose its heat, if external temperature is lower than the temperature of the body. Dead body now behaves as an inert mass and continues to lose heat rapidly at first due to a greater temperature difference between dead body and environment and then slowly till its temperature reaches that of environment. Progressive heat loss is regarded as a good scale for estimation of time since death in cold countries.

Humphry Davy suggested use of thermometer for recording of the body temperature, **Robert C. Dowler** adopted its use for medico-legal

investigations and **Sheard** was of the view that heat loss represented by conventional simple graph depends upon processes of radiation, convection, conduction or vaporization. He thought that this loss of heat from body is in accordance with Newton's law, which states that rate of loss of heat at anytime is directly proportional to temperature difference between surface of object and its surroundings. Newtonian graph is of simple exponential type showing rapid fall initially followed by a slow progressive fall till the temperature matches that of the environments. Human cadaver has considerable mass of definite shape, composed of many different types of tissues and organs having variable conductivity of heat. The covering fat conducts heat poorly compared to other tissues. Body surface therefore cools more rapidly than the center of the body. Central temperature remains unchanged for first few hours. Most reliable site to record the body temperature in a corpse is its inner core and usual site selected for this purpose is either rectum or sub-hepatic site in cases of sexual assault to avoid contamination.

A special graduated mercury thermometer should be used to record body temperature. Depth is essential for which bulb of thermometer is placed about four inches deep into the rectum or sub-hepatic site, so that the temperature of the inner core is recorded. In case the thermometer has Fahrenheit grading, the range is 50-100° and for Centigrade grading, it is 20-50°. Four readings, each at an interval of half an hour should be taken in situ. The curve of temperature loss of the cadaver placed in cool environments is of sigmoid shape. (**Fig 12.2**)

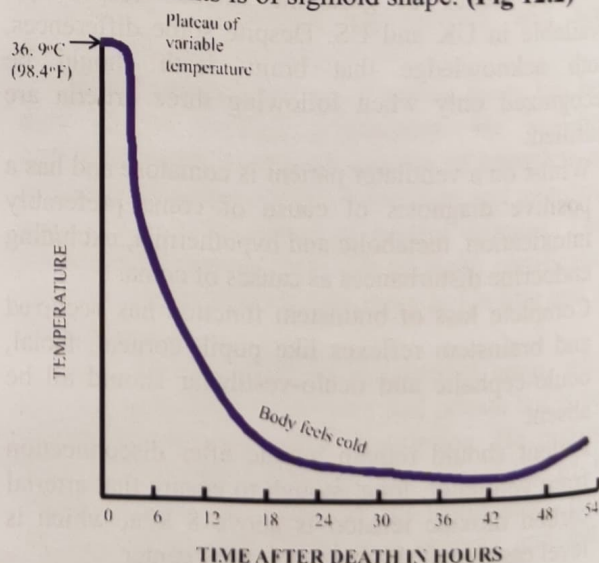


Fig 12.2: Postmortem curve of fall of body temperature

Normal body temperature at the time of death is considered at 98.6° or 99.0° F. and in most deaths; there is no appreciable rise or fall in this body temperature. But there are certain cases, in which the temperature may be sub-normal, as is generally seen in deaths from congestive cardiac failure, massive hemorrhage, secondary shock, exposure to cold and intoxication by alcohol or barbiturates. Similarly in some cases, temperature may rise even up to 110.0° F at the time of death, as seen in deaths from infection, pontine hemorrhage, heat stroke and asphyxia. Another factor, which modifies results, is the general physique. Fat is a bad conductor so heat loss is slower in fat people. Washing accelerates heat loss. Air movement, lack of ventilation and clothes over the dead body, bedding, all affect the body and alter the results. (Fig 12.3)

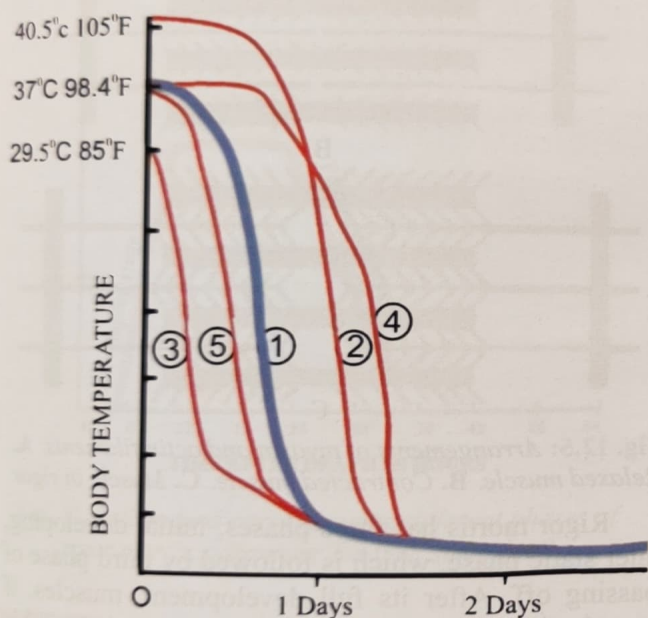


Fig. 12.3: Cooling curves of dead bodies having 1. Normal temperature 2. Initial high temperature 3. Initial low temperature 4. Fatty or heavily clothed 5. Thin or unclothed

Hypostasis is appearance of red coloration on the skin after death due to gravitational pooling of blood in the dependent and unsupported portions of the body. Blood accumulates in capillaries, distends them and makes them show up on the surface of the skin and internal organs as areas of purple-red discoloration termed as *postmortem lividity* or *hypostasis*. Though the process of shifting of blood starts immediately after cessation of circulation, yet its appearance externally occurs in twenty to thirty minutes or may even be delayed up to two hours. The shape and depth of the discoloration also varies with

time. Initially it appears as scattered faint small patches. Gradually these patches grow in size and the color deepens. In about six to twelve hours, they unite to form an extensive area of uniform discoloration.

Any pressure anywhere on the body, however slight, will prevent the capillaries from filling and that is why pressure areas due to weight of the body, wristwatch, corset, belt and brassiere do not show hypostasis. Any change in the position of the body in the first few hours would change the site of hypostasis. However, after two to three days the red blood cells disintegrate and blood coloring pigments are liberated. These stains skin, subcutaneous tissue and internal organs permanently and changing the position of the body at this stage does not shift the distribution of the staining. Because of its relationship with time, it also acts as a parameter for time since death.

Determination of site, shape and color of hypostasis is important to know the position of the corpse, type of dress worn at the time of death and the cause of death. In asphyxia, the color of hypostasis has a cyanotic tinge, and in deaths due to poisoning by aniline, carbon monoxide and hydrocyanic acid, the color of hypostasis is brown, cherry red and pink, respectively. The extent of appearance depends upon the nature and the amount of blood in the body at the time of death, in traumatic death, extensive loss of blood occurs and the coloration on the surface is faint. (Fig. 12.4 & Photo. 12.1)

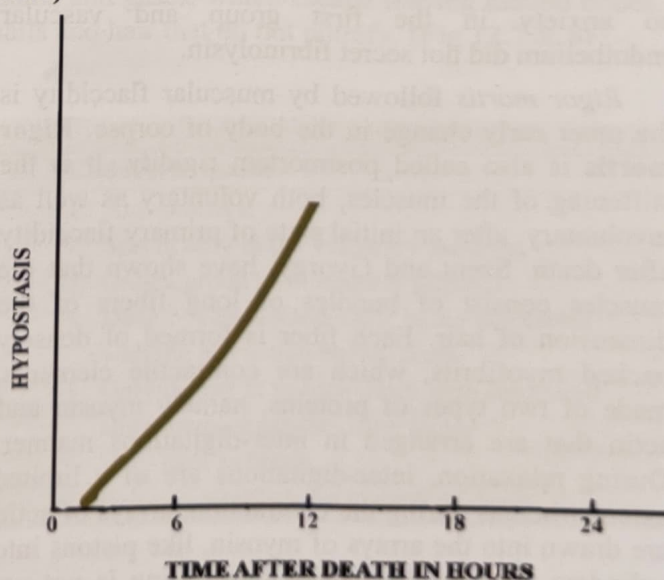


Fig 12.4: Postmortem curve of development of hypostasis



Photo.12.1: Areas of contact flattening (whitish) and hypostasis on the back of deceased

Fudin studied 500 dead bodies dying from chronic natural deaths due to cancer, tuberculosis or pneumonia and immediate traumatic deaths due to suffocation, electrocution or attack of angina.

In the first group, death was expected and the blood coagulated in patches, which became firm and did not dissolve till putrefaction. In the latter two groups, the deceased was unaware of the fate and whole blood coagulated quickly into ordinary clot, which within fifteen to thirty minutes dissolved. This change kept the blood in fluid state till putrefaction. The only difference in the two groups was presence or absence of agony in the period prior to death felt by the dying person. In the second, the death was sudden and unexpected, it made the deceased emotionally tense and death was painful having an agonal period. It stimulated production of fibrinolysin by vascular endothelium into blood circulation, which dissolved the already formed clot. There was no anxiety in the first group and vascular endothelium did not secrete fibrinolysin.

Rigor mortis followed by muscular flaccidity is the other early change in the body of corpse. **Rigor mortis** is also called postmortem rigidity. It is the stiffening of the muscles, both voluntary as well as involuntary, after an initial state of primary flaccidity after death. Szent and Gyorgyi have shown that the muscles consist of bundles of long fibers of the dimension of hair. Each fiber is formed of densely packed myofibrils, which are contractile elements, made of two types of proteins, namely myosin and actin that are arranged in inter-digitations manner. During relaxation, inter-digitations are of a limited extent whereas during the contraction, arrays of actin are drawn into the arrays of myosin, like pistons into cylinders. The mechanism of this sliding is not yet fully understood except that the process is dependent upon the presence of enzyme adenosine triphosphate.

After death, adenosine triphosphate of the cell decomposes. Both the actin and myosin become stiff and get converted into a rigid gel having no reaction to electrical stimuli. This condition is irreversible making the muscles firm and unable to stretch and this state of muscles is called rigor mortis. (**Fig. 12.5**)

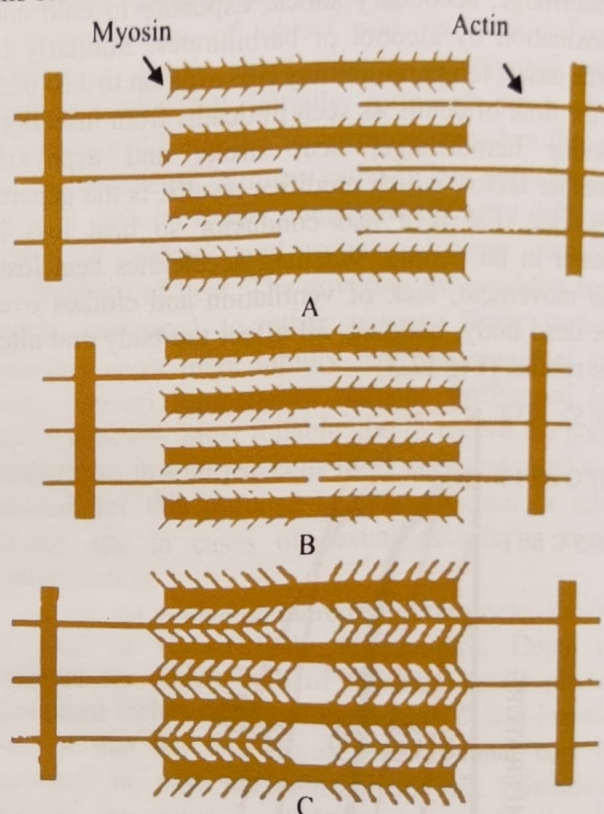


Fig. 12.5: Arrangements of myosin and actin filaments. **A.** Relaxed muscle. **B.** Contracted muscle. **C.** Muscle in rigor

Rigor mortis has three phases; initial developing, later static phase, which is followed by third phase of passing off. After its full development, muscles, if stretched get torn. Period of each phase is variable ranging from four to twelve hours depending upon circumstances in which the corpse lies. As a rule of thumb, average duration for its development, stay and passing off is four to six hours each in summer and ten to twelve hours in winter. Factors affecting the process of rigor mortis are general physique, emotional state of the deceased at the time of death and environmental temperature. Although rigor mortis takes place in all muscles simultaneously, yet smaller muscle groups manifest it earlier than larger muscle groups. This apparent progression of rigor mortis in the body is proximal to distal making it look as if it occurs on the face first, going down to the upper limbs and then to the lower limbs. Presence or absence of rigor mortis can be elicited by attempting to flex the neck and the limbs, at joints. If

it is fully developed, flexion is difficult rather impossible requiring great force. The body will behave as if made of wood and lifting the head will raise it straight without any flexion at the joints.

Rigor mortis should not be confused with **cold** and **heat stiffening**. Rapid freezing of the dead body especially in the mortuary freezer precipitates cold stiffening, suspending the process of rigor mortis. When body warms up during de-freezing, rigor mortis appears quickly and also passes off very rapidly. Similarly, in case of heat stiffening, at temperatures above 149° F, muscle proteins become coagulated producing rigidity in the muscles. If all the muscle proteins are coagulated, rigidity is far more intense than that found in rigor mortis. (Fig. 12.6)

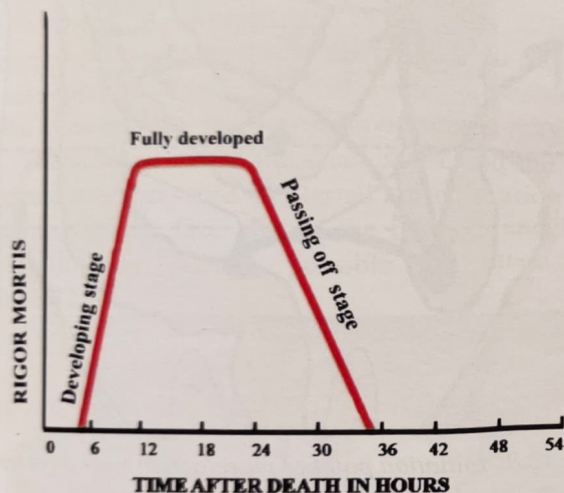


Fig. 12.6: Standard curve showing different phases of rigor mortis, parameter for time since death

Table 12.4:

Differences between rigor mortis and cadaveric spasm

Rigor mortis	Cadaveric spasm
1. Postmortem.	1. Anti-mortem.
2. Involves both voluntary as well as involuntary muscles.	2. Sets in only in the voluntary muscles.
3. Muscles of the whole body are affected.	3. Only a group of muscles is affected.
4. Has a specific pattern of development being preceded and followed by stages of flaccidity.	4. Develops instantaneously, being associated with the last action before death
5. Occurs in all deaths.	5. Only occurs in sudden death with emotional stress being a predisposing factor.
6. Moderate force is required to break the rigidity.	6. Very hard to break.
7. Has no relation to establishment of the manner of death.	7. Helps to establish the manner of death.

Cadaveric spasm is one of the most important ante-mortem phenomena in which strong stiffening occurs instantaneously in certain group of muscles that are in action at the moment of death in a person, who is emotionally tense. Its recognition and differentiation from rigor mortis is of immense importance during autopsy examination. (Table 12.4)

Late physical change in the corpse after somatic death is **decomposition** also called **putrefaction**. It occasionally gets replaced with other conditions like adipocere formation or mummification, depending upon specific environmental circumstances in which the deceased lay after death as very late physical changes. It is in fact rotting of the soft tissues of the dead body including internal organs and *the last change*. Complex soft tissue including organs break and disintegrate into smaller components. The rate of putrefaction varies with certain factors like temperature, water and bacterial content.

Process of decomposition begins at 50-60° F and is most favored at the range of 70-110° F. It is retarded between 110-220° F at which temperature the probability of mummification is greater. The moisture is essential and the body contains sufficient amount of water for this process to occur. The presence of air and organisms promotes the process and their absence retards it. Mutilated bodies putrefy more rapidly. **Casper's dictum** states that the process of decomposition in air is twice as rapid as in water and eight times as rapid as in the soil. All the soft tissues of the body eventually are converted into fluids and gases, which escape leaving behind bones, nails and hair that do not putrefy. (Fig 12.7 & 8)

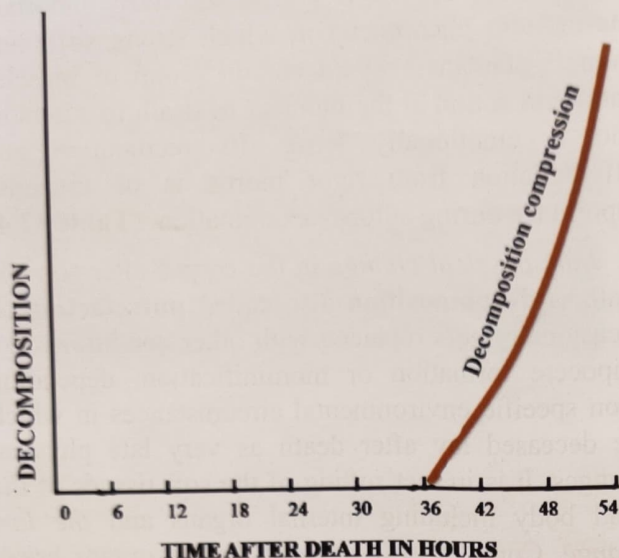


Fig. 12.7: Postmortem curve of progression of decomposition

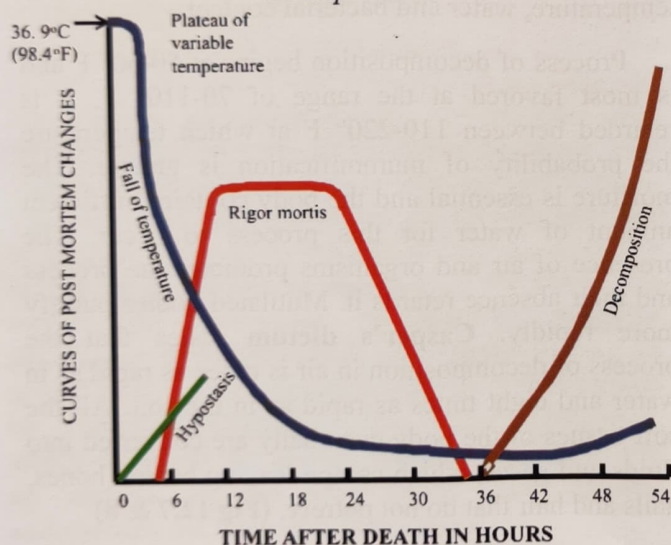


Fig. 12.8: Four curves of loss of body temperature, hypostasis, development of rigor mortis and decomposition being parameters for determination of time since death

Two processes namely autolysis and bacterial action contribute to convert soft tissue. Autolysis softens and liquefies soft tissues caused by the digestive action of enzymes released from cells after death. While autolysis is on, bacteria in the body namely *E-coli*, *staphylococcus*, *streptococcus viridans* and predominantly *clostridium welchii* invade the tissues. Most of these bacteria come from bowel especially from the cecum on the right side of the abdomen where the contents of the bowel are fluid and full of these bacteria. From here, these gas-forming bacteria grow into the adjacent tissues. Warmth, moisture and a suitable medium like blood

are essential for their growth. They invade the main systemic veins through the portal circulation and disrupt blood causing hemolysis and staining the tissues and the skin of the cadaver.

Skin discoloration appears first on the right side of the abdomen, when the cadaver is lying on its back, as dark brown and then green due to formation of sulfurated hydrogen and sulfmethemoglobin. It extends from here to the other parts of the abdomen, followed by a similar appearance of discoloration in front of the chest and root of neck extending to both shoulders. (Fig. 12.9)



Fig. 12.9: Initiation point of putrefaction with direction of its spread (marked by arrows)

By this stage, the green color changes to blackish brown and veins in these areas become prominent and visible due to accumulation of gases in them due to decomposition and shows *marbling stage*. Incision in a vein under water shows gas bubbles. Blistering and bloating of body tissue occur simultaneously under pressure of putrefying gasses mostly in the region of lower abdomen and groin. The epidermal layer of the skin gets loosen from dermal layer forms into blister and also causing slipping of the loosened epidermis due to pressure precipitating *skin-slip stage*. The blisters vary in size ranging from two to four inches and they are incompletely filled with blood stained watery fluid. The blisters burst leaving the base moist and showing no vital reaction. The postmortem blisters and skin-slip may erroneously be attributed to scalds produced with wet burns. The decomposing gases also accumulate under the skin of the abdomen distending it and the scrotum. (Photo.12.2)



Fig.12.2: Early putrefaction of corpse showing dark brown discoloration of abdomen, bloating of scrotum and loosening of epidermis with blistering

Formation and liberation of gases mainly sulfurated hydrogen, methane and ammonia, emit disagreeable smell. It blows up the soft parts especially of face producing *bloating stage*, which causes puffing, eyelids, protrusion of tongue. The gases in the stomach and intestines distend them forcing bloodstained fluid to come out of the nose and mouth. The postmortem purging of fluids from the nasal and the oral orifices in the early stages of decomposition may easily be misinterpreted as a sign of ante-mortem bleeding. Fecal matter is pushed out of the anus and the fetus in a gravid uterus may drop out. The soft tissues of the face, cheek and the body crepitate on pressure. External discoloration and bloatment of the face change the features and facial recognition is hardly possible at this stage. (Photo.12.3)



A



B

Photo.12.3: Advanced putrefaction of corpse **A.** recovered tied with rope flexing both arm and legs. **B.** After removal of rope. Both photos showing blackish discoloration and advanced ballottment of face with protrusion of tongue, chest, eyes, shoulders, arms and massive loosening of epidermis, blister formation and skin slip

Eventually the distended abdomen bursts showing similar changes in the internal organs. Decomposition of the internal organs may be divided into two groups, those, which putrefy early and others, which putrefy late. Brain liquefies first. Liver and spleen become honeycombed and flabby. Other organs including lungs, heart and kidneys start shrinking but remain identifiable for many months. Gall bladder causes greenish diffusion. Prostate and non-gravid uterus being compact organs having dense fibrous tissue remains recognizable when decomposition of all other organs has far advanced. This helps in determining the sex.

The time of appearance of putrefactive changes is variable and depends on the cause of death, physical development of body and environmental factors such as temperature, air being dry or humid, water being cold, dirty, stationary or running. The time sequence of events may only be predictable in a wide range. (Table 12.5)

Table 12.5:

Order of decomposition of internal organs

Early	Late
Larynx and trachea	Lungs
Costal cartilage	Heart
Intestines (large)	Kidneys
Intestines (small)	Urinary and gall bladder
Omentum and mesentery	Testes
Liver and spleen	Prostate
Brain	Non gravid uterus

Infestation by housefly in the dead body during postmortem period is due to attraction of these flies by foul smell of decomposition around third day of the start of putrefaction. They lay eggs at the body orifices, mainly in the nostrils, eyes and between the lips inside the mouth. If the body is naked, lying of eggs also takes place at the vaginal and anal openings.

The maximum number of eggs laid by a single adult fly is 2000, in groups of 150. Eggs hatch at a temperature of 80° F in twelve to fourteen hours and at 50° F in about three days. The larval stage persists for three to four days by which time, they become pupae, and pupae take another three to four days to become fully formed flies. When the weather is cold, the whole cycle is delayed for few days. Flies quickly finish the soft tissues within days. (Photo.12.4)

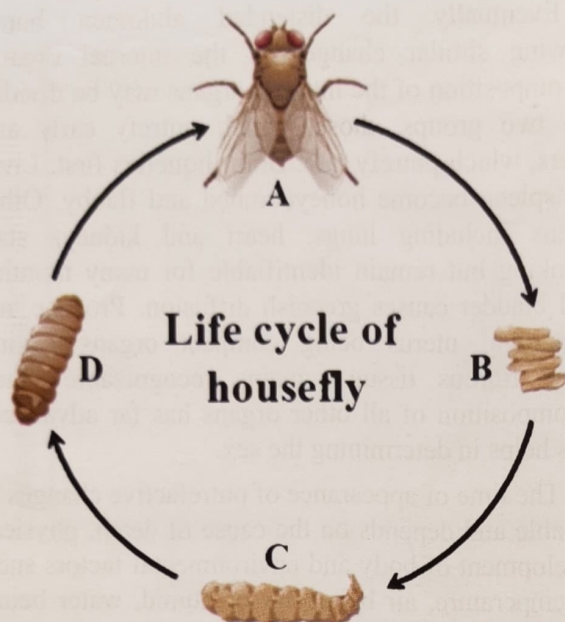


Photo.12.4: A. Adult fly B. Eggs. C. Larva. D. Pupa

Collection of specimens of larvae and pupae of the fly for entomological studies is an important duty during autopsy examination. Several specimens of live as well as dead larvae and pupae, each of largest size should be taken and preserved either by dropping them in boiling water for two to three minutes and then stored in refrigerated containers. The preferred preservation fluid contains 85cc of 90% alcohol, 10cc of 40% formaline and 5cc of glycerine. Specimen preserved in this solution retains their shape and color. It is also necessary to send the soil around and beneath dead body as the soil may also contain pupae. This study helps estimation of postmortem time. (**Photo. 12.5**)

Maceration is physical change that occurs in a dead fetus if it remains in the womb for some time after death. It is aseptic autolysis of soft tissues of the dead fetus. The change should not be confused with the process of putrefaction and intrauterine infection of the fetus, which generally follows use of instruments for the criminal interference to rupture the membranes.

Shanklin (1964) compiled tables of degree of maceration in organs with the known time of fetal death. He in a survey of 53 human stillbirths found that in great majority of cases, the estimated time of intrauterine death fell within these limits. **Thomson** described both **gross** and **microscopic changes** in maceration and correlated them with probable time of intrauterine death:



Photo.12.5: Housefly attacking dead body under decomposition A. upper trasso showing larvae/pupae around openings of eyes, nostrils and mouth B. Lower traso around anal opening

- **Gross changes** start with the appearance of brownish-red discoloration of the skin, which occurs within few hours of fetal death except hemorrhagic discoloration around the umbilicus. The cuticle is raised in blisters and peeling. Gross skin slippage occurs after twelve hours. It emits a somewhat rancid smell unlike the odor of putrefaction. In an advanced stage, the body is soft and flaccid. When placed on the table, it flattens out unable to maintain its contours and bones of the head are mobile. After few days, there is difficulty in dealing with such a fetus owing to liquefaction. Internal organs of liver and spleen are softened. The medico-legal significance of maceration is that when present, it is indisputable evidence of intrauterine death and should be differentiated from other changes following death of the fetus
- **Microscopic changes** are that there are quantitative changes in skin, kidney, liver and lungs. There is shrinkage of epidermal nuclei, 54% being affected within one to one and half hour and 70% after five to six hours. Small blebs appear due to lyses of the epidermis and dermis, which occurs within an hour and finally vesiculation, occurs in twelve hours. In the kidney, nuclei of the cells lining the ducts of

Bellini lose their central position. The change is progressive for six hours and after 12 hours cells become shrunken and dissociated. In the liver, flaking of red blood cells occurs in about 90 minutes. The bile duct epithelium begins to slough after twelve to fifteen hours. In the lungs, changes are similar with sloughing of bronchial epithelium after six hours. It differs from other postmortem phenomena that it retains its staining properties even after 150 hours. (Table 12.6)

Very late changes after death are mummification and adipocere formation:

Mummification occurs due to heat drying of the tissue aided by currents of air. It is mostly met with adults in desert conditions or in newborns hidden in chimneys. Such environment facilitates evaporation of water causing sufficient drying, leather hardening and shriveling of the body tissues. The skin becomes tight over the bones and joints and the tissues stay preserved. The time of development is variable depending on the general physique, anti-mortem dehydration and bacterial content. The recognizable stage is said to occur in fourteen to sixteen weeks in summer.

Adipocere formation is another late change, which means fat or wax and is the best description for the changes occurring in soft tissues of the body converting them into soft, grayish white, crumbly or greasy material after death. The mechanism of its formation is not fully known but it is believed that *Clostridium Welchii* initiates the process of hydrolysis and hydrogenation of the body fats.

It has been noticed that superficial fats are initially affected in patches, being first seen in cheeks, breasts and buttocks. Finally, the process spreads to the whole body. Once formed it is relatively permanent. It has a characteristic smell. Recent chemical studies into adipocere formation conducted by **Mant** both during conduction of autopsies and in the laboratory have shown that adipocere changes invisible to the naked eye start within days of death, but the recognizable adipocere

takes about three months or even longer. These laboratory experiments were carried out to know the factors influencing the process such as electrolytes, pH of the medium, effect of presence of skin or subcutaneous tissue and the role of *Clostridium Welchii*.

The conditions required for its formation are sufficient fatty tissue and presence of moisture or adequate humidity of the surrounding air. Excess of water is unnecessary and running water might retard its formation due to washing out the electrolytes. Presence of electrolytes in normal physiological concentration is essential. Excess calcium has no effect. Adipocere formation is a chemical change, thus both heat and cold affect its rate of formation. It is retarded by cold, and accelerated by warmth. Partial absence of oxygen, an anaerobic condition as is seen in most deeply buried bodies is most conducive to its formation. But too much oxygen or absolute absence of oxygen inhibits its formation. Once formed, it is relatively permanent.

Adipocere consists of fatty acids and admixture of mummified remains of muscle, fibrous tissue and nervous tissue (**Mant** and **Furbank**) and spherical crystals with radial markings (**Evans**). A constant feature is the absence of defined cells. Even staining does not help to identify tissues. Fresh fats contain 0.5 percentage of fatty acid. It rises to 20% within four weeks and 70% within twelve weeks or even more when it is obvious to the naked eye.

The chemistry is still not fully agreed upon. Regarding properties of adipocere, it has the greasy consistency of wax and fat, which crumples on handling and floats in water. Its color is grayish white or yellowish white. It has a characteristic rancid smell. It melts on heating and burns with a yellow flame. It is easily dissolved in hot alcohol and ether. Medico-legal importance of both mummification and adipocere formation is in the preservation of facial anatomy of the deceased for years. It helps personal identification and to some extent determination of the cause of death in cases of injuries.

Table 12.6:

Differentiating features of delayed postmortem phenomenon

Feature	Putrefaction	Maceration	Mummification	Adipocere formation
Color	Greenish to black	Purple red	Dusky brown	Yellowish
Order	Foul	Sweetish	None	Specifically characteristic
Feel	Crepitant	Fluctuant	Hard	Soft
Body contour	Lost partially	Flattering of the body	Preserved	Preserved
Facial feature	Lost gradually	Lost rapidly	Preserved	Preserved

Scavenger's invasion of the corpse along with other carnivorous animals, for example ant, cockroaches and rat all finish soft tissue by eating. Rats and rodents nibble the skin mostly of limbs, ants and cockroaches remove the surface epithelium at specific areas such as nose, corners of the mouth, eyes and along wrinkles in the skin of the face, which are moist. Other animals like vultures, jackal and dogs rip apart soft tissue, fish and crabs under water precipitate ravage and cause bites marks and tearing of the tissues of limbs, scavenging thoracic and abdominal cavities to the extent of evisceration. The damages produced may simulate ante-mortem injuries like incised and lacerated wounds. The examination of such injuries, when made through a magnifying lens shows no vital reaction and teeth marks become clearly visible at the periphery of the damage. Denuded area dries rapidly and presents a brown parchment like appearance which may be mistaken for scratches or abrasions. (photos.12.6, 7, & 8)



Photo.12.6: Ant-bite showing no vital reaction



Photo.12.7: Scavenging of upper limbs and thoracic-abdominal cavities



Photo.12.8: Scavenging by dog of scalp and face

Eye changes of the most important ones occur in cornea, sclera and retina:

- Corneal changes are either temporary or permanent haziness. If the eyes remain open after death, drying of the cornea produces temporary haziness in the first few minutes. This temporary haziness is followed by permanent haziness, which converts it to milky and opaque in about 12 hours. At this stage, light does not pass through it.
- Sclera becomes brownish in color and the area of discoloration is called *taches noires*. It is triangular in shape having bases towards the cornea. Full development occurs in 3-4 hours, provided the eyes remain open. Retinal changes are noticed with the help of an ophthalmoscope, every three hours up to twelve hours. Cornea had to be moistening before each examination. During the first three hours, retina becomes pale and the area around the optic disc yellowish. The choroidal vascular pattern, which appears as a red background, remains clear but by about the third hour starts becoming hazy. During the next three hours, the whole background becomes pale and homogeneous. By the end of six hours, the optic disc outline starts fading away, and only the larger segmented vessels can be seen against the background of expanding grayish-yellow discoloration. After nine hours, the grayish-yellow discoloration reaches the periphery of the disc, which can only be located by convergence. After twelve hours, all traces of the disc and retinal vessels disappear and only a deep brown macula can be made out.

Chemical changes in body fluids such as blood, cerebrospinal and ocular fluids are said to be due to continuance of function of bacteria and enzyme in various organs during period between clinical and cellular death. Alteration in the permeability of dying cells also plays some part.

Blood changes beside pH are in levels of sugar and urea:

- Blood and tissues' pH initially falls and then rises. Fall is because of terminal accumulation of carbon dioxide, gluco-genolysis and glycolysis with phosphoric acid and lactic acid accumulation. During the agonal period, there is acidosis, which also plays a part. After 24 hours, pH rises and the reaction becomes alkaline owing to production of ammonia from protein breakdown, Ultraviolet curve shift is non-specific.
- Blood sugar and its significance during postmortem period are related to the breakdown of liver

glycogen leading to an accumulation of dextrose in the inferior vena cava. It diffuses into the right side of the heart, raising the blood sugar concentration in these cavities up to 300-mg/100 ml within the first twelve hours. It does not extend beyond the right heart. Elsewhere in the body, the dextrose is broken down after death and free dextrose disappears from blood in about six to eight hours. The rate depends on body temperature (Hill). It means that no reliance can be placed on the blood sugar level in the inferior vena cava and right heart. Whenever blood sugar level examination is required, blood should be collected from limbs especially for the diagnosis of hyperglycemia. Care must also be taken with interpretation of the elevated levels because an agonal rise in blood dextrose can occur in hypoxia, carbon monoxide poisoning and trauma. During the first twelve hours, there is a gradual rise in non-protein nitrogen to about 50-mg/100 ml, amino-acid nitrogen upto 10-mg/100 ml and creatinine upto 10-mg/100 ml.

- Blood urea rise after death is irregular because of proteolysis but serum level within the first 48 hours is never above 100-mg/100 ml, unless there is an increased urea concentration during life. In death associated with uremia, the serum level is greater than this so the postmortem diagnosis of uremia becomes possible. In assessing the urea concentration, it must not be forgotten that urea concentration can rise during the agonal period to a level over 150 mg/100 ml. Serum concentrations of urea and creatinine above 300 mg and 10 mg/100 ml, respectively indicate renal failure with uremia.

Chemical changes in eye fluids both in aqueous and vitreous humor have been investigated and it has been found that ascorbic acid level does change but the change is too variable to be of any value. Other changes are in the level of potassium and lactic acid, which have been studied. There is a consistent rise in the concentration over one hundred and twenty five hours. The rise appears to be unaffected by body temperature. Lactic acid, pyruvic acid, vitamin C and non-protein nitrogen changes are erratic.

Changes in cerebrospinal fluid are both in its volume and concentration of various contents. Being filtrate of blood plasma, it has a higher concentration notably of chloride and magnesium and the volume of cerebrospinal fluid soon after death is about 150 ml. After twenty-four, it gradually disappears. Mason, Klyne and Lennon (1951) investigated the

postmortem rise in potassium and other constituents over about 60 hours. Diffusion of constituents like lactic acid, non-protein nitrogen and amino acids were non-specific.

Sudden death is type of death in which certification of its cause cannot be done with confidence by medical practitioner either due to insufficient history of illness, clinical symptoms and medical supervision. Cause of death in such cases should only be determined following an autopsy examination. All sudden deaths, whether **natural** or **unnatural**, should be investigated to determine cause of death before final disposal.

Natural deaths are generally 80% of all deaths in a community, which is a significant portion of total mortality and is uncommon between ages of one to thirty. The most common causes of such deaths are clinically silent degenerative disease, fulminating infection or malignant growth in almost every organ system. Men greatly out-number women as the victim of this type of demise. *Unnatural deaths* constitute a lesser proportion of total number of deaths and according to the World Health Organization, they form 5th largest group of causes of death.

Greatest percentage of natural causes follows the involvement of the cardiovascular system. The mechanisms of death in this system in order of increasing suddenness are hemorrhage from a vessel, peripheral blockage of a vessel, and inhibition of the action of the heart. The extent of hemorrhage from a vessel depends upon two factors, namely the size of the bleeding vessel and the ability of the area involved to tolerate the accumulation of blood. With smaller vessels, the effect is less but given the same size in the cranial or the pericardial cavity, the lethal effect may be because of concurrent effect on the functioning of these organs.

The mode in death due to peripheral blockage of a vessel depends upon three factors, namely site of the obstruction, nature of the part deprived of the blood supply and the method of occlusion. The primary effect is deprivation of oxygen to a part or organ and the secondary effect is on the body as a whole, which in turn depends upon the function of the organ affected. For example, blockage of the blood vessels supplying blood to the spleen generally has no effect on the body whereas blockage of the blood vessel supplying blood to cardiac or respiratory center will cause almost sudden death.

Three main processes lead to blockage of an artery. Slowest in effect is the reduction of the lumen of a vessel due to atheromatous thickening. Faster in effect is the occlusion of the blood vessel by local thrombosis due to abnormal clotting of blood within the vessel as seen in disseminated intravascular coagulation or single clot formation in an area of damage to the blood vessel lining. It occurs both in arteries and veins. The fastest in effect is sudden blockage due to embolism. The fragments of the preformed clot break off and in case of arteries detached particles are forced into vessels of decreasing size to produce infarction, i.e. death of the part supplied by the occluded vessel. The victim may die suddenly. When in veins, detached particles go to the heart first through vessels of increasing size and finally occlude the main pulmonary artery, which is again rapidly fatal. Cerebral and cardiac embolism is arterial and pulmonary is venous in origin. (Fig. 12.10)

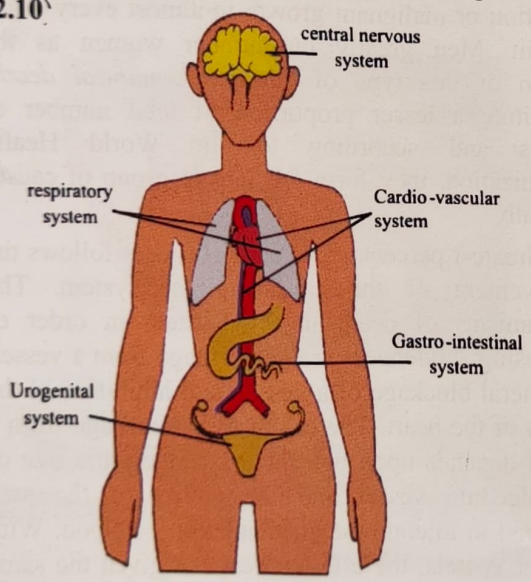


Fig. 12.10: System wise causes of sudden death

The deaths due to inhibition of the action of the heart can occur when the heart or its blood vessels are perforated and blood gets collected in the pericardial sac precipitating cardiac tamponade. Blockage of the coronary vessel leads to loss of heart function precipitating many complications. Diseases of the heart tissue such as inflammatory or toxic diseases or simply excessive load imposed may inhibit cardiac function. Finally, initiation of counteraction may also result from the inhibition of the heart through abnormal stimulation of the regulatory nerves as in vagal inhibition. (Fig. 12.11 & 12.12 & Table 12.7)

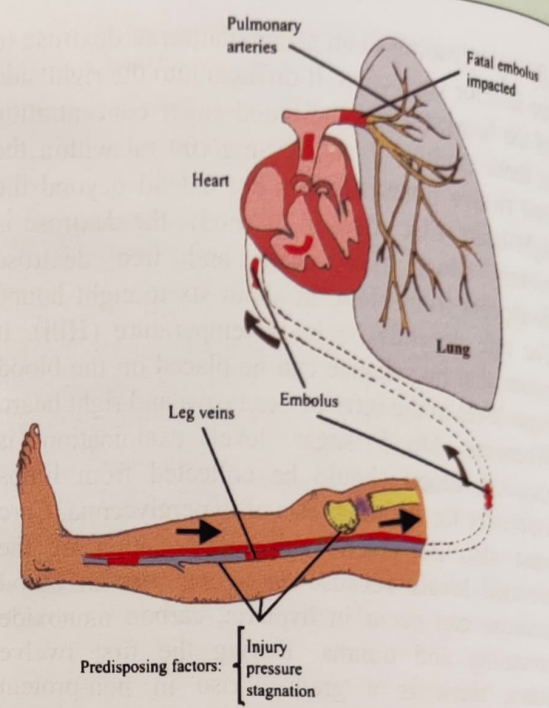


Fig. 12.11: Pulmonary embolism

Table 12.7: Common natural causes of sudden death	
Cardio-vascular system	
Heart	Coronary artery disease, hypertensive heart disease, aortic stenosis, myocardiopathies
Great blood vessels	Atheromatous and dissecting aneurysms
Nervous system	
	Sub-arachnoid and cerebral hemorrhages, epilepsy
Respiratory system	
	Pulmonary embolism, tumor, TB, asthma and viral pneumonia
Gastro-intestinal system	
	Perforated viscus, mesenteric thromboembolism, G.I. hemorrhages
Urogenital system	
	Tumors of testis, ovary, uterus and cervix, abortion, ruptured ectopic pregnancy

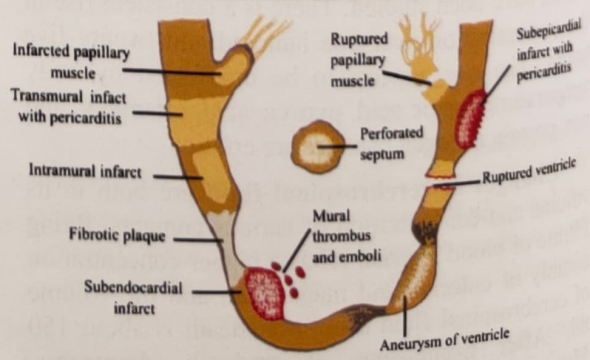


Fig. 12.12: Sequelae of coronary occlusion

Next to cardio-vascular system in order of occurrence of sudden death is the involvement of the nervous system. Death generally occurs due to hemorrhage into the brain tissue e.g. apoplexy, aneurysm or embolism of the cerebral vessels and cystic tumor or abscess, which may rupture into the ventricles.

Respiratory system is the third in order of occurrence of sudden death mainly due to the formation of tumor or abscess. Other important causes of death in this system are allergic or infective manifestations of the glottis as seen in diphtheria or tumors of the larynx and bronchi embarrassing respiration and pulmonary embolism after childbirth or fracture of limbs or major surgery.

The causes of death in gastrointestinal tract located in the abdomen are due to rupture or hemorrhage from gastric or duodenal ulcers and tumors of the stomach or colon. The common cause in the uro-genital system in male is tumor of testes whereas in the female are tumors of ovary, uterus and cervix besides rupture of extra-uterine gestation or an ovarian cyst, which can cause sudden shock and death. Deaths due to neuro-genic shock show no anatomical finding. History and circumstantial evidence in such cases may suggest death due to vaso-vagal shock.

Certification of cause of death is a highly important and essential duty of the medical practitioners. World Health Organization has, for his guidance, designed "*international certificate of cause of death*", which has since been adopted throughout the world. Medical practitioners, while preparing the certificate of cause of death has to answer three questions regarding cause of death on a certificate:

- What was cause of death?
- What is meant by cause if several morbid conditions are concerned?
- How best can I express on the form what is required by statistical officer?

Statements on the form call for:

- *Morbid condition* directly leading to death
- *Conditions antecedent* to it being the underlying causes of death
- *Other contributory conditions* not related to the direct or antecedent causes.

In order to obtain correct and factual data on the distribution of diseases, it is essential that the medical

practitioner realizes what is required of him in using the international form of medical certificate of cause of death. The use of this form places upon him the responsibility of indicating the *course of events*, since he is in a better position than anyone else to decide which condition led directly to death and what antecedent conditions, if any, gave rise to the direct cause. It is a new principle in mortality statistics.

Disease or condition leading directly to death

On line 1(a) of the form, the condition, which was the direct cause of death, is entered. This entry does not mean the mode of dying (e.g., heart failure, respiratory failure), which should not be stated at all since it is no more than a synonym for the fact that death has occurred and provides no useful information. Actually, it means the disease, injury or complication, which directly preceded death. It can be the sole entry on the certificate if only one condition was present at death, or it may be a complication, such as peritonitis, toxemia or septicemia. Next, it is considered whether the direct cause arose as a consequence of any antecedent disease or injury or if it was a complication or delayed result of these. Was there an intermediate step, or stage, between normal health and the development of the direct cause of death?

Antecedent causes

The condition, if any to be entered on line 1(b) must be considered to have been antecedent to the direct cause both in respect of time and of etiological or pathological relationship, the direct cause being "due to" it or "as a consequence of" it. If it is believed to have prepared the way for the direct cause by damage of tissues or impairment of function, a condition can be entered as antecedent although a long interval of time has elapsed since its onset or since the occurrence of symptoms from it. In the case of an injury, the form of external violence or accident producing it is antecedent to the injury described in I (a) and can properly be entered in I (b) although the two events are almost simultaneous. Hypothetical constitutional states or factors which may have proceeded or pre-disposed to, a well-defined disease should not be entered as antecedent causes.

Before an antecedent condition is entered in I (b), it must be considered, whether there was any other condition antecedent to it in the same sense as described above. If so, then this antecedent condition was the starting point in the chain of related events

leading to the direct cause. In that case, the starting point of the whole series should be entered in I(c) and the most important of the intervening conditions

on line I (b). On no account must the starting point of the sequence be entered in part II because of lack of space for it in part I. (Fig. 12.13)

INTERNATIONAL FORM OF MEDICAL CERTIFICATE OF CAUSE OF DEATH	
Cause of Death	Interval between Onset and Death
I Disease or condition directly leading to Death*	(a) _____ due to (or as a consequence of)
Antecedent causes, morbid conditions if any, giving rise to the above cause, stating the underlying condition last.	(b) _____ due to (or as a consequence of)
II Other significant conditions contributing to the death, hut not related to the disease or condition causing it.	(c) _____

* This does not mean the mode of dying e.g. heart failure. asthenia. It means the disease, injury or complication, which caused death

Fig.12. 13: Structure of Death Certificate

If, it is thought that there has not been any antecedent conditions as defined above, lines I (b), and (c) are left blank.

Other significant conditions

After completing part I, the medical practitioner must consider whether there was any other condition which, though not in the causal sequence in part 1, contributed something to the fatal outcome. If so, this can be entered in part II. Such a condition must not be related to the direct cause of death. Entry here may be made of normal pregnancy, if it is thought to have contributed anything to the fatal issue, or of a chronic disease in a person who died from an accidental injury.

Interval between onset and death

Where the interval between reported onset of each condition entered on the certificate and date of death is known, even approximately, it should be entered in the column provided for the purpose. This information will provide a useful check on the sequence of causes in part I, as well as information about the duration of illness of certain diseases.

A few of illustrative examples are chosen and reproduced as ready reference to facilitate fill the international certificate of cause of death from the book named "Medical certification and rules for

classification of causes of deaths" published by the Government of Pakistan, Ministry of health.

Illustrative examples

1. Child dying of toxemia in an attack of diphtheria. It is sufficient to certify as follows:

- I. (a) Diphtheria 4 days
2. Child dying of pneumonia following measles. The direct cause of death is pneumonia, and measles is antecedent both in time and causal relationship.
- I. (a) Pneumonia 6 days
- (b) Measles 3 weeks

The underlying cause is measles.

3. Adult dying of peritonitis resulting from perforation of a duodenal ulcer, an epithelioma of the skin also is present.

- I. (a) Peritonitis 2 days
- (b) Perforation of duodenum 4 days
- (c) Duodenal Ulcer 6 months
- II. Epithelioma of skin of cheek 3 months

The underlying cause is duodenal ulcer.

4. Elderly man dying of hypostatic pneumonia after being bed ridden owing to fracture of neck of femur caused by fall from a ladder at home.

- I. (a) Hypostatic pneumonia 1 day
- (b) Fracture of neck of femur 7 days
- (C) Fall from ladder at home 7 days

The underlying cause is fall from ladder at home.

5. Adult aged 45 dying of mitral incompetence which originated in an attack of rheumatic fever 20 years before.

- I. (a) Mitral incompetence 3 months
 - (b) Mitral endocarditis 20 years
 - (c) Rheumatic fever at the age of 25 20 years
- (No recent sign of activity)

The underlying cause is chronic mitral endocarditis of rheumatic origin.

6. Adult dying of shock following removal of the gall bladder for cholecystitis arising from gallstones, chronic nephritis also being present.

- I. (a) Postoperative shock 3 hours
- (b) Cholecystectomy after cholecystitis 5 hours
- (c) Gallstones 6 months

II. Chronic nephritis.

The underlying cause is gallstones.

7. Woman dying of eclampsia immediately after prolonged labor caused by contracted pelvis, albuminuria having been observed before delivery began.

- I. (a) Eclampsia after childbirth 12 hours
 - (b) Toxemia of pregnancy 2 months
- (Albuminuria)

II. Contracted pelvis, prolonged labor.

The underlying cause is toxemia of pregnancy.

8. Elderly man dying of cerebral hemorrhage after many years history of arteriosclerosis with symptoms suggestive of senile degeneration and enlarged prostate, but without hypertension or albuminuria.

- I. (a) Cerebral hemorrhage 2 days
- (b) Arteriosclerosis Many years
- II. Prostatic hypertrophy 2 years

The underlying cause is cerebral hemorrhage.

9. The following illustrates the importance of accurately stating the sequence of morbid conditions in order to allow selection of the cause considered 'underlying' by the medical practitioner.

A diabetic patient who has been under insulin control for many years suddenly dies from a degenerative heart condition. Depending on the role played in the fatal outcome by one or other condition, or both, the following entries are possible:

i) If the heart condition resulted from the longstanding diabetes, the sequence would be

I. (a) Myocardial degeneration.

(b) Diabetes.

The statistical office would select diabetes as the underlying cause of death, with the heart condition as a complication causing death.

ii) If the heart condition developed independently of the diabetes, the two conditions would be entered.

I. (a) Myocardial degeneration.

(b) Diabetes.

The heart disease would be recorded as the underlying cause, with diabetes merely a contributory condition.

iii) If a patient suffering from both conditions dies from some other complication of diabetes, the heart condition playing only a subsidiary part in the death and without certainty that it arose from the diabetes at all, then the certificate should be in the form

I. (a) Coma.

(b) Diabetes.

II. Myocardial degeneration.

Each of the above certificates could be correct and would not be questioned by the statistical office.

Determination of cause and manner in sudden death is one the most important responsibility of Forensic Medical Examiner and he generally utilizes two types of information's for this purpose:

- *Circumstantial component (including anamnestic information)*
- *Medical component of deceased*

Circumstantial component is obtained from the victim and all other persons attending the victim during terminal stage. It includes statements of witnesses about the circumstances surrounding victim's death and his behavior at the terminal stage along with any medical background information of the deceased from family members, doctor or medical institution.

Medical component is autopsy examination of deceased. Forensic autopsy is recommended throughout the world for obtaining the medical component of all sudden deaths, whether natural or unnatural.

After the collection of the above data, it is compiled to evaluate the cause and manner of death, which is an interpretative two steps intellectual exercise:

- Recognition of the organic structural changes and chemical abnormalities, which are responsible for cessation of vital functions
- Grasping of the mechanism by which anatomical or chemical deviation from normal actually caused death.

Medico-legal autopsy may conclude into the possibilities that the cause of death.

- i. Established beyond doubt by fully identifying the disease or injury
- ii. Determined from the findings with a degree of probability nearing certainty
- iii. Decided primarily by anamnestic facts, which are supported or confirmed by positive or negative anatomical or biochemical findings
- iv. Not established as autopsy examinations do not provide sufficient evidence for it

It is emphasized that halfhearted or partial autopsies must be discouraged, rather condemned. Incomplete medical examination of the dead body subsequently requires the arduous procedure of exhumation with all its attendant limitations, which is rarely rewarding as compared to initial searching and complete one.

Number of negative autopsies is very little. All persons connected with such deaths including investigating police believe that the autopsy shall reveal the cause of death. They insist that the cause of death be given. It must be realized that negative autopsies do result in best of hands.

In the case of negative autopsy, medical examiner is advised that he should explain limitation in the situation admitting his inability to certify the cause of death.

Registration of death by the authority, in most countries is subject to prior determination of the cause of death and the disposal of the corpse is only permitted then. The attending physician has a duty to certify the cause of death to the best of his ability. Otherwise, he reports the case to the police or corner or any other authority for arranging an autopsy or in some cases additionally holding an *inquest* to know the cause of death.

Heasman pointed out the danger of disposing off dead bodies without proper investigation. According to him, the autopsy results regarding cause of death differ from the cause of death decision of the attending physician to the extent of 40% and this difference was not about opinion alone but is about facts.

Medico-legal system works for primary purpose of establishing the cause and manner of death. Conventionally such a system was initially associated with the detection of crime. But now, it is equally important for accidental deaths whether on the road, in the industry or at home to recommend proper preventive measures. Success of the system revolves round proper collection of physical evidence at the crime scene and dead body and its proper preservation (**Table 12.8**)

Table 12.8:

Types of physical evidence

- Physical evidence associated with the crime scene
- Medical evidence associated with the dead body
- Circumstantial evidence (anamnestic data) of the case

Above steps are inseparable and should be done by respective agencies together for good results and the team should consist of Forensic science Expert, Forensic Medical Examiner and law enforcement agency like Police. Preservation of the scene in diagrams and photographs both in color and monochrome and of physical evidence present at the scene is the duty of Forensic science Expert. Preservation of medical evidence associated with the dead body is the responsibility Forensic Medical Examiner. Compilation of circumstantial evidence of the case is undertaken by law enforcement.

After preservation of the scene and physical evidence, Forensic Medical examiner makes the preliminary inspection of the dead body at the scene and arranges its transfer to autopsy center. The corpse is carefully wrapped in a clean plastic sheet and then sent under police escort. After the removal of the dead body, he visits and inspects the site and collects any additional information, which may have been missed previously. Police maintains peace and order at the scene of crime and also collects the details of circumstantial evidence including anamnestic data pertaining to deceased. The person in charge of the

investigation should be adequately educated, experienced and employed exclusively for this purpose. He should have proper authority over the dead body and all others who are connected with the investigation. He should be independent, free from local and national politics. These points have been stressed and recommended.

Medico-legal System operative in other countries

are:

- Coroner system (United Kingdom)
- Medical examiner system (United States of America)
- Continental system (Europe)

Coroner system is a very ancient system. The original English coroner was the principal officer of the Crown and had extensive common law jurisdiction over the dead bodies within his area of control to hold inquest. Recent developments have reduced his powers and now he can only investigate sudden and unexplained deaths including deaths in police custody. He can, however, still hold an inquest for this purpose. Under the new rules, the qualification for appointment to the post of present day coroner is either medical or legal degree with five years of professional experience from the date of registration with the Medical Council or admission to the Bar.

Medical examiner system has been developed in America for the investigation of cause of all sudden and unexplained deaths. He is medically qualified officer enjoying almost the same powers as the English coroner, having achieved them by special legislation except the power of inquest. He may, however, obtain all necessary information about the circumstantial aspects of the case from the concerned persons in private.

Continental system makes provisions for the investigation of all sudden or unexplained deaths, but only those deaths are subjected to investigation in which suspicion of foul play exists. A system, which is not activated until suspicion of crime is present, defeats its own purpose. There is no identifiable

executive officer. In this system, criminal deaths are reported to the police who inform the area judge through the public prosecutor. Both the public prosecutor and the judge may be highly qualified officers but they are only casually concerned with the investigation. The reputation of police fails to solicit wholehearted cooperation of those having knowledge of the circumstances of the case or crime.

Both English coroner and American Medical Examiner can order an autopsy with minimum of delay. Therefore, autopsy rate is higher in both these systems. *Autopsy rate* is the proportion of autopsies carried out on deaths notified to the authorities. *Autopsy index* on the other hand is the proportion of medico-legal autopsies carried out on the total deaths in any community (Turkel). Autopsy index provides more useful indication of the efficiency of medico-legal system.

In Pakistan, **modified continental system** is operative. Section 174 of criminal procedure code empowers the area Station House Officer (SHO) of police to investigate suicide, homicide and deaths due to accident or ones occurring in other suspicious circumstances. All sudden and unexplained deaths are not investigated. Only those deaths are subjected to investigation, which are reported to police. Under the law, SHO informs about the crime to the area magistrate and if thinks necessary may send the corpse to authorized qualified medical practitioner for autopsy provided he is in doubt regarding the cause of death. He has the authority to dispose of these cases even without autopsy. All reported cases are therefore not subjected to autopsy. Autopsy rate is very low.

Postmortem artifact is a feature that gets added to the original autopsy findings during terminal dying stage due to agonal phenomenon and or resuscitation, while transporting or handling of the corpse during postmortem period and interference by scavengers. Its recognition is important and necessary to avoid misinterpretation of medically significant ante-mortem findings. Postmortem artifact lacks vital reaction and can easily be recognized by the trained eye. (Table 12.9) (Next page)

Table 12.9:

Classification of postmortem artifacts

Causation	Postmortem artifact	Misinterpretation
During terminal dying period		
Agonal	Regurgitation and aspiration of gastric contents into the air passages	Choking
Resuscitation	Injection marks on the limbs, neck and chest	Addiction or violence
	Bruising of the skin of chest	Violence
	Fracture of ribs and sternum	Violence
	Bruising of the heart	Violence
During Postmortem period		
Situational	Pseudo groove on the neck by tight collar	Ligature mark
Handling	False bruising in the occipital region	Head injury
	Fracture of cervical spine	Violence
	Dislocation of shoulder and hip joints	Violence
	Breaking of the rigor mortis	Non-appearance
Decomposition	Bloatment	Obesity
	Bloody fluid in the mouth and nose	Poisoning or violence
	Hypostatic, localized discoloration of subcutaneous tissue	Bruising
	Arte-factual hemorrhages in tissue spaces and body cavities	Violence
	Decomposition gas bubbles in right heart and major blood vessels	Air embolism
	Rupture of stomach wall due to acid digestion	Corrosive poisoning
	Separation of skull sutures in infants	Violence
	Rigor of heart muscles	Concentric hypertrophy
	Localized or regional flattening of cerebral gyri	Cerebral edema
	Localized blackish brown staining of liver with bile or sulfides from large bowel	Bruising
	Bluish discoloration of intestinal loops in the pelvis due to decomposition	Infarction
Animal	Shrinkage of facial skin	Hair growth
	Nibbling by rats and rodents	Incised wounds
	Ravage by fish and crabs	Incised wounds
	Ripping apart by vultures	Lacerated wounds
burning	Heat ruptures of skin and scalp	Open wounds
	Flaking fractures of long bones and skull	Ante-mortem fractures
	Burning hematoma inside the skull at the site of maximal to heat	Intra-cranial exposure
	Fat droplets in pulmonary vessels	hemorrhage
		Fat embolism
During autopsy		
Faulty technique	Introduction of air bubbles in the blood vessels of brain and neck	Air embolism
	Pseudo bruising in the subcutaneous tissue of the neck	Throttling
	Introduction or extension of fractures in the skull bones during instrumentation	Ante-mortem Fractures

13. Death occurring during the process of Asphyxia

Asphyxia is important happening during life of a person, which causes interference with process of oxygenation in lungs and its essential ingredient is struggled breathing. Proper understanding of asphyxia depends upon the following information:

- **Physiology of fatal asphyxia**
- **Biochemistry of fatal asphyxia**
- **Pathology of fatal asphyxia**

Physiology of fatal asphyxia has been experimented and studied by Swann and Brucer on dog, while inducing mechanical obstruction, breathing carbon dioxide and other gas mixtures. Results are that there is great individual variation in animal survival. Unconsciousness occurs in about one minute followed by death in two, three or at the most four minutes, having **three phases** of extremely short duration.

- *Phase I* initiates stimulation of respiratory center increasing both rate and amplitude of respiratory movement. Cyanosis begins to appear, blood pressure and pulse rate remain unchanged.
- *Phase II* is characterized by struggle to breathe, which starts with expiratory type of breathing. Cyanosis deepens with engorgement of neck veins. Generalized congestion and petechaeal hemorrhages start appearing. Victim becomes confused and later goes unconscious.
- *Phase III* is dominated by unconsciousness, which leads to coma. Breathing becomes irregular, shallow, gasping and mostly inspiratory type. The rate of respiration is slow having long intervals. Respiration finally fails, but the heart continues to beat for some time. Pupils get dilated and conjunctivae become unresponsive to touch. Diastolic blood pressure falls low, but systolic pressure remains unchanged till heart stops. Struggle to breath in fact increases oxygen requirements and thus hastens death.

Biochemistry of fatal asphyxia is more relevant. Besides reduction in level of oxygen with increase in level of carbon dioxide in circulating blood, there is lowering of blood pH to acidic side. Blood sugar level rises with exchange of sodium and potassium ions across cell membrane. This atmosphere of the cell is conducive to its death producing pathological changes of degenerative nature.

Pathology of fatal asphyxia is histological changes in tissues associated with anoxia causing lowering of blood oxygen level. Nerve cells, venules and capillaries are very susceptible to lack of oxygen. Nerve cells die immediately and small blood vessels respond by dilatation precipitating stasis of blood both within venules and capillaries. Capillovenous engorgement with rise in the level of carbon dioxide in circulating blood produces generalized congestion and cyanosis. Anoxia also increases permeability of capillary wall forcing fluid out into the tissue spaces and this transudation of plasma into tissue spaces cause edema. Capillaries eventually rupture causing blood leaks of small size out of these vessels. These petechaeal hemorrhages were noticed first by **Tardieu** and are identified with his name as **Tardieu's spots**. They occur in the substance of the organs, but are more readily seen under their serous coverings. Capillary endothelium under stress secretes fibrinolysin, which keeps the blood in fluid state. When these changes are sufficiently marked, they become visible as *general pathological changes*. (**Table 13.1 & Photo.13.1 with Fig.13.1**)

Table 13.1:

General pathological changes in asphyxia

- Generalized cyanosis
- Vascular congestion
- Edema of the tissues and viscera
- Petechaeal hemorrhages in the skin and viscera
- Fluidity of blood

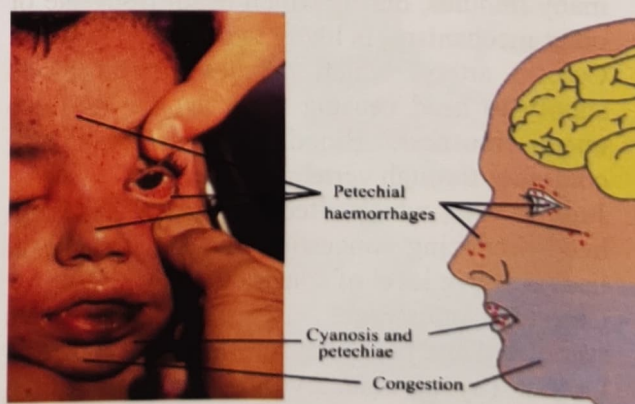


Photo.13.1 with Fig.13.1: Classical facial features of asphyxia

Asphyxia is classified in the following types (Table 13.2)

Table 13.2:

Types of asphyxia

- **Mechanical*** Unnatural obstruction of air passages from within or outside
- **Pathological** Transfer of oxygen to lungs is prevented by blockage caused by a disease of respiratory tree
- **Toxic** Uptake of oxygen is prevented in the lungs due to the presence of some poisonous gas like carbon monoxide
- **Environmental** Insufficient oxygen in the inspired air (*vitiated atmosphere*) as in deep well or closed space
- **Iatrogenic** Associated with medical procedure like as during anesthesia and surgery

* Important from forensic medicine point of view

Main problem faced by Forensic Medical Examiner is that *ante-mortem anoxic degenerative and postmortem autolytic changes* in tissues microscopically appear similar and cannot be differentiated.

Mechanical asphyxia is important from forensic medicine point of view. It is defined as mechanical constriction of neck caused from without or blockage of air passage from within. It requires revision of neck anatomy, because of compression, whether partial or complete obstructing breathing mechanism and blood flow in neck due to pressure on:

- i. Windpipe, which causes generalized oxygen deficiency. Sufficient compression to stop airflow within stiff/rigid cartilage of larynx/trachea is very difficult. Usual mechanism is for larynx to be lifted up so that tongue blocks back of the throat. In any event, pure deprivation of air can be survived for many minutes, during which death from one or other mechanisms is likely to occur.
- ii. Carotid artery, which reduces arterial blood supply to head causing brain anoxia and also unconsciousness. Blood flow to head still continues through vertebral vessels.
- iii. Jugular vein, which affects venous return from head producing congestion and hemorrhage in tissues above level of constriction.
- iv. Carotid sinus/vagus nerve, which gets stimulated and precipitates reflex cardiac arrest.
- v. Larynx (hyoid bone/thyroid cartilage), which fractures by two mechanisms: direct pressure on bone and indirect pressure through thyrohyoid ligament, producing in addition injuries

to related soft tissues. Common sites of fracture are greater cornue of hyoid bone and superior horn of thyroid cartilage especially when it is calcified as in advanced age. It is necessary to mention that fracture of body of hyoid bone or thyroid cartilage generally follows a direct blow like in karate. (Fig 13.2, Table.13.3 & fig 13.3)

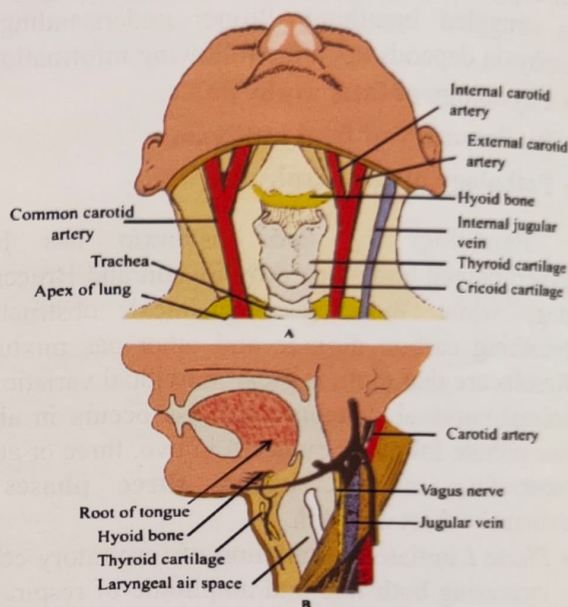


Fig. 13.2: Structures interfered with neck compression

Table 13.3:

Summary of neck compression effects

Windpipe	Oxygen lack
Carotid arteries	brain anoxia and unconsciousness
Jugular veins	Congestion and hemorrhages of brain and tissues above level of constriction
Pressure on carotid sinus	Stimulates vagus nerve precipitating cardiac arrest

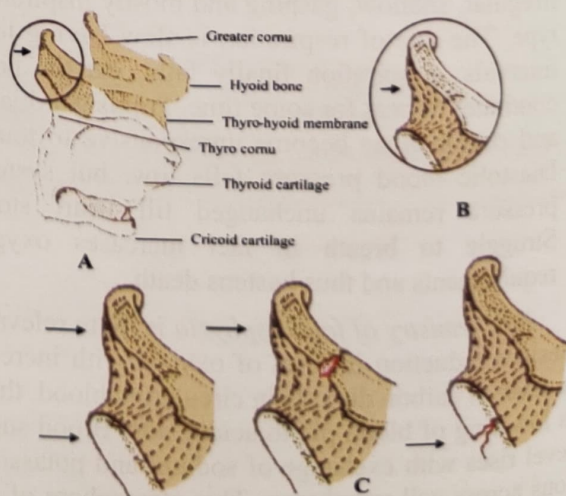


Fig.13.3: A. Larynx showing pressure point B. Cutout encircled portion magnified C. Mechanism of fractures

There are five levels of obstruction; starting from external openings of nose and mouth as in suffocation, going lower down to glottis, larynx and upper trachea in neck as in hanging, strangulation, throttling and choking, which gets blocked by inhalation of a foreign body such as vomit's, button or fruit stone to final lowest level of lungs as in traumatic asphyxia, which occurs due to mechanical immobilization of chest as happens in stampede. (Fig. 13.4 & Table 13.4)

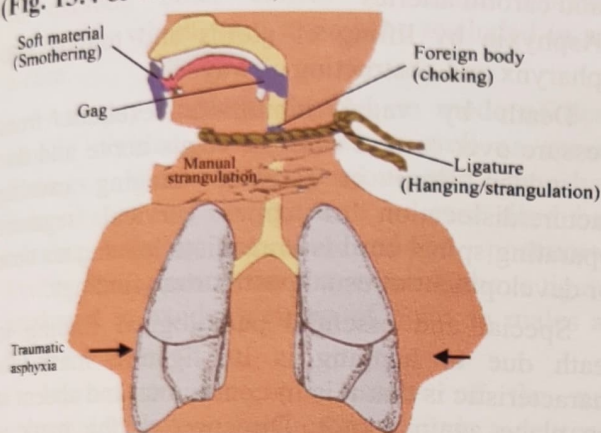


Fig. 13.4: Diagrammatic levels and types of mechanical asphyxia

Table 13.4:

Level of obstruction with type of mechanical asphyxia	
Level	Types
Nose and mouth	Suffocation (Smothering and gagging)
Glottis	Hanging
Larynx and upper trachea	Strangulation, throttling
Trachea or main bronchus	Choking
Muscles of respiration	Traumatic of asphyxia

Suffocation is defined as manual obstruction of air passage to respiratory tract caused by closing of external orifices of nose and mouth. It is the purest form of asphyxia. It is done in two ways, **smothering** and **gagging**:

- **Smothering** is closing of air passages externally either by hands or using a material like soft pillow or adhesive tape.
- **Gagging** is stuffing of mouth cavity with cloth and blocking entry of air into these passages.

Medico-legal importance of suffocation is that suicide is not possible and it is mostly homicidal. Homicidal group includes cases of killing of infants by smothering and gagging. Commonest method is placing a soft pillow or palm of hand over nostrils and mouth and forcefully closing these openings by finger pressure. Both smothering and gagging by strapping is employed to keep back calls for help especially in cases of house breaking and sexual

adventure. Accidental group occurs in all ages; infant, child, adult and old. An infant may either die in prone position with face buried in soft pillow. Other possibility is death occurring due to overlying of infant by mother going to sleep while feeding or under heavy sedation. Amongst children of the ages of seven to eight years, it is a specific hazard with plastic bags. A child may use a polythene bag as helmet over his face to identify with a space man. A tight one will get molded to nose and mouth blocking external openings completely. Amongst adults it is not common unless victim is ill or intoxicated who cannot offer resistance. An old, infirm or intoxicated man may fall facing downward in mud and die in this position. (Photo. 13.2 & 13.3)



Photo.13.2: Suffocation (Smothering) by adhesive tape, additionally showing strangulation with azaar-band



Photo.13.3: Suffocation (gagging) by stuffing of cloth into mouth

Autopsy findings mostly are general pathological asphyxial i.e. cyanosis, venous congestion, fluidity of blood, petechaeal hemorrhages and edema of lungs/other tissues. Petechaeal hemorrhages are on face and conjunctivae. Specific local findings occurring at nose and mouth are bruising of the skin, mucosa of nose and lips due to pressure over them. There may be rupture of lip mucosa. Postmortem staining in infants lying face downward shows areas of pressure showing absence of lividity. (Photo.13.4)

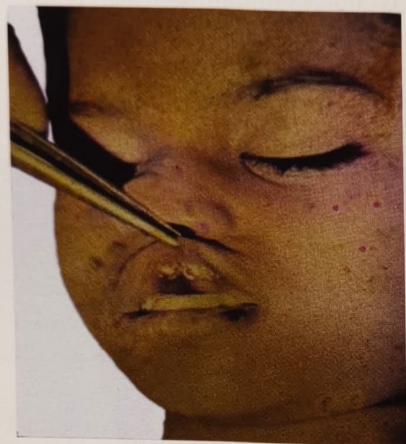


Photo.13.4: Smothering showing bruising of lips and petechaeal hemorrhages on the nose and cheek

Hanging is defined as constriction of the neck by a ligature, constricting force being applied indirectly through weight of the body. Hanging can take place with victim in standing, semi-reclining or sitting position provided pressure on neck is such that it is sufficient to occlude windpipe and neck blood vessels. Death is possible from such low elevations as door-knobs, bed-heads and hook for cloths. (Fig. 13.5)



Fig. 13.5: Different positions of hanging from highest to lowest point of suspension

According to **Brouardel**, jugular veins close by a tension of 4.4 pounds, carotid artery by 11 pounds and trachea by 33 pounds. **Poison and Gee** confirmed these findings, dividing hanging into two types; *complete* or *incomplete* and *typical* or

atypical in complete hanging, victim's body is suspended with feet off the ground, in typical hanging, ligature knot is at occipital region where as in atypical mostly at side of face.

Mechanism of death in hanging includes cerebral anoxia, reflex cardiac arrest and pure asphyxia, which is the most common. Death in most cases results from combination of two causes;

- Cerebral anoxia by compression of jugular veins and carotid arteries
- Asphyxia by lifting of glottis and tongue into pharynx and obstructing airway

Death by vagal inhibition resultant from pressure over carotid sinus or vagus nerve and due to sudden drop in judicial hanging causing fracture/dislocation of upper cervical segment separating spinal cord is immediate leaving no time for development of usual postmortem findings.

Special and essential pathological finding in death due to hanging is its ligature mark. Its characteristic is that it is in-continuous and absent at the place against knot. Direction of the mark is oblique going upward towards the knot. It is an imprint abrasion usually situated in upper part of the neck above thyroid cartilage. In partial hanging, it may be lower down even below the thyroid cartilage. It is well-defined groove with hard material like rope, wire or belt and depth of the groove is not uniform being deepest at a point opposite to the knot and gradually becoming shallower towards it. Groove may suggest type and width of ligature material. Weaves of the rope or studs of the belt may be imprinted on the skin. Its definition is diffuse with soft material like cloth. If a jute rope is used, it leaves traces on the skin. (Photo.13.5)

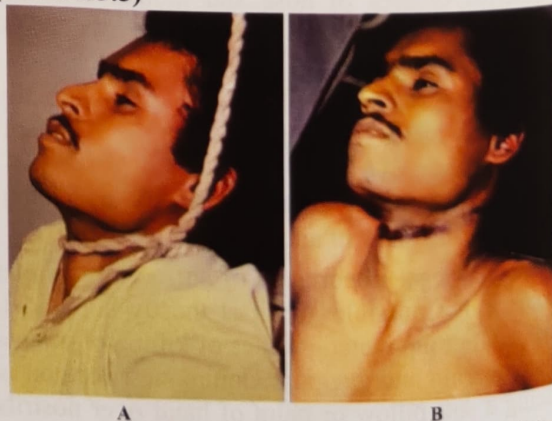


Photo.13.5: Of hanging A. Corpse with rope with its knot in position around neck B. Corpse without rope, ligature mark more deep in center, oblique going upward reducing in depth and absence at site of knot

Medico-legal importance lies in whether it is ante-mortem or otherwise. It requires careful examination of scene of the occurrence and corpse. Presence of vital reaction in the skin and deeper tissues in relation to ligature mark will point to ante-mortem hanging. Area of hyperemia and ecchymoses along the edges of the groove is a definite ante-mortem sign and its presence can be confirmed histology. Autopsy should be complete to exclude other causes of death especially poisoning, which must always be excluded in such a case.

Autopsy findings depend on mode of death, usually divided into general as well as specific findings. Visceral congestion and petechaeal hemorrhages are not marked. In case dead body remains hanging for some period, postmortem lividity will appear at an area of neck above ligature mark and in hands, feet, tip of penis in males and breasts in females.

Injuries to the soft tissues of the neck immediately below the ligature include a degree of bruising of connective tissue and muscles of the neck and rarely tears in the blood vessels. Fracture of the hyoid bone or thyroid cartilage is a rare finding occurring only in about 3-5% cases.

Decision as to whether hanging is suicidal or homicidal is difficult. Suicidal hanging is more common in females and those committing suicide usually leave a note.

Strangulation may be defined as constriction of neck by a ligature and constricting force being applied directly to ligature. Homicidal cases are common. Accidental cases are those of infants killed by loop of umbilical cord. Suicidal strangulation is rare and is only possible when a device to keep the pressure on the neck is used. A variant of strangulation is **garroting** in which victim is attacked from behind. A piece of rope, cloth or even a flexible branch of a tree is passed over the head, placed in front of the neck and pulled to press air passage against the vertebrae. Main objective is to overpower the victim with onset of unconsciousness.

Autopsy findings are general asphyxial changes. Intensity of cyanosis, visceral congestion and petechaeal hemorrhages is marked. Special pathological change is a ligature mark on neck, which may have single or more loops. Ligature mark may be situated at any part of the neck but usual place is over the lower part of the larynx and

upper part of the trachea. It is all around the neck, directed transversely across it. (Photo.13.6)



Photo.13.6: of strangulation with hard material showing acute facial congestion, horizontal and continuous ligature mark of uniform depth all around neck. **A.** Left view **B.** Right view

Ligature is retained in position in homicidal cases with knot usually firmly tied in front. Internal damage is bruising of soft tissues of neck such as fascia, muscle sheaths, muscles or even blood vessels in area of pressure. Hyoid bone usually and thyroid cartilage occasionally is fractured. Important differentiating features of hanging and strangulation are tabulated. (Table.13.5)

Table.13.5:

Differentiating features of hanging and strangulation

Feature	Hanging	Strangulation
Ligature		
Length	Long	Short
Application	Single turn	More turns
Knot	on back of neck	In front of neck
Ligature mark		
Site	High up in the neck	Middle of neck
Direction	Oblique	Horizontal
Extent	Incomplete	Complete
Knot imprint	occipital side of the neck	In front if present
Depth of the groove	Decreases towards knot	Uniform
Other		
Nail marks	Absent	Present (parallel or vertical above ligature mark)
Cyanosis	Mild or absent	Intense
Facial congestion	May be present	Marked
Petechaeal hemorrhage	Scanty	Numerous

Manual strangulation (throttling) is constriction of neck of a person by other person with one or both hands. **Mugging** is compression of the neck of the victim with bend of elbow or by applying a foot or knee to the neck. Suicide is not possible and cases of homicide following sexual assault are common occurrence.

Mechanism of death is cerebral anoxia due to external pressure on windpipe from front and sides. Reflex cardiac asystole takes place due to variations of tension within carotid sinuses:

- Increase tension occurs either by occlusion of the carotid artery above the sinus or by application of pressure on the carotid sinus. Increased tension precipitates strong parasympathetic stimulation and produces inhibitory circulatory effects such as slowing of pulse, depression of myocardial contractility and conductivity and generalized vasodilatation.
- Decrease tension occurs due to application of pressure on carotid artery below the sinus. Decreased tension produces strong sympatho-adrenal stimulation accelerating rate of pulse and increase in myocardial contractility, conductivity and generalized vaso-constriction with rise in blood pressure.

Sudden sympatho-adrenal or parasympathetic stimulation leads to circulatory failure, which proves fatal. Deaths occurring by such mechanisms are usually very rapid and of special medico-legal significance. (Fig. 13.6)

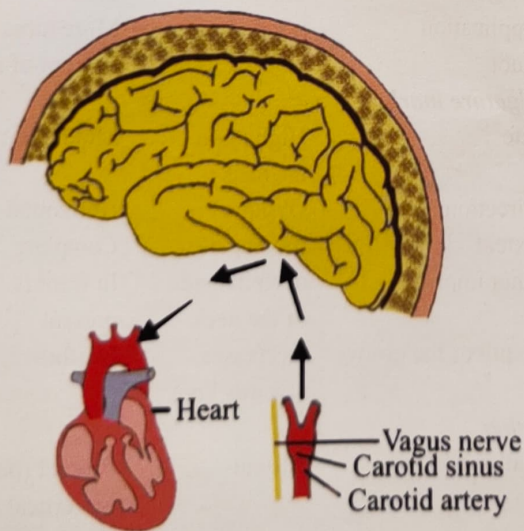


Fig.13.6: Reflex cardiac arrest through Vagus nerve

Cerebral anoxia occurs due to occlusion of blood vessels supplying blood to the brain. Closure of arteries and veins causes stagnation of circulation producing anoxia, coma and death.

Autopsy findings vary with mechanism of dying. Amongst general pathological findings, facial congestion, cyanosis and petechaeal hemorrhages are prominent, usually seen in areas above level of constriction. Specific findings depend upon method of throttling whether with one hand or both hands or with forearm and whether from front or behind. Bruises due to pressure of finger-tips having adjacent nail marks are characteristic and present in front or both sides of the neck. (Photo.13.7)



Photo.13.7: Throttling showing bruising and finger nail marks

Adjacent neck soft tissues under skin such as fascia, muscle sheet, muscles and retropharyngeal tissue also get bruised due to pressure against spine along with fractures of laryngeal structures. In severe cases, base of the tongue may also be bruised.

Dissection of neck in such cases is ruled by the consideration of thorough exploration with precaution that no seepage of blood from neck vessels occurs into surrounding tissue to avoid artifact bruising, which may get added in the neck soft tissues during postmortem exploration. Finding may simulate ante-mortem bruising and its recognition is of immense importance. **Schrader** advised complete drainage of blood from neck by removing contents of head and chest before starting neck dissection. **Prinslo** and **Gordon** recommended wider primary incision of neck for exploration in situ and neck X-ray before actual exploration and histological examination of the suspect tissue. (Fig. 13.7)

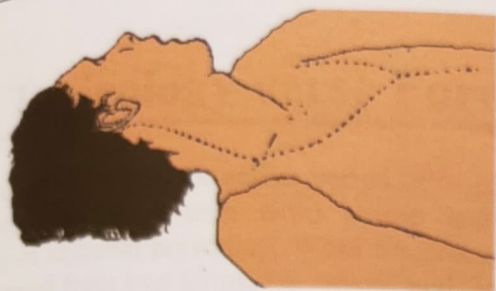


Fig. 13.7: Primary incision of neck for wider exploration

Other specific finding is fracture of thyroid cartilage or hyoid bone. Recognition of fracture of these structures is of great value in diagnosis of throttling. Decomposition may present difficulties with the recognition of both external as well as internal bruises and diagnosis of throttling will mostly depend upon presence of fracture of thyroid cartilage or hyoid bone. In putrefied body, this is the only corroborative finding. (Photo.13.8)



Photo.13.8: Fractured hyoid bones preserved during autopsy A & B. Fresh corpse's C. Exhumed corpse under advanced decomposition

If victim of violent attempt of asphyxia survives, he may take one of two possible courses:

- Irreversible cerebral ischemia producing permanent neurological deficit leading to a vegetative state
- Reversible cerebral ischemia causing no neurological deficit and consciousness will be regained rapidly.

Resultant effects of interference with respiration such as petechaeal hemorrhages, bruising and skin ligature mark will persist for two or three weeks, initially becomes red and swollen with initiation of inflammatory process and will disappear gradually. A crust forms on epidermis, which dries, retracts and falls off in about three

weeks. Laryngeal injury gives rise to difficulty in swallowing and may cause hoarse voice. Fractures of thyroid cartilage and hyoid bone heal by bony union in about six weeks (Thomas and Kluyskens).

Choking is blockage of air passages from larynx to any part of upper trachea down to the carina by a foreign body. It is another example of the purest forms of asphyxia. It is mostly accidental and victim of such a catastrophe is a child who places coins, buttons or beads in his mouth, which may slip down into the upper air passages. In mentally ill and intoxicated individual, a portion of food bolus in mouth may trickle down into the air passage and block it. Homicidal choking is common in infants. In these cases, a soft plug is pushed into the trachea through the mouth with an idea to kill the child and conceal the crime.

Iatrogenic choking may result from loose tooth during dental procedure, detached piece of tracheal cartilage during tracheotomy or surgical swab during surgery on throat, which may go down into the larynx or trachea.

Mechanism of death is anoxic anoxia. Reflex cardiac inhibition may also occur during an attempt to dislodge foreign body.

Autopsy findings are non-specific general pathological asphyxia changes with specific finding of foreign body lodged in the trachea. The mucosa of the trachea at the site of lodging of the foreign body is bruised.

Traumatic asphyxia is immobilization of chest and is always accidental. Victim is crushed at chest under a heavy weight or lateral pressure of a crowd. A female may die of forceful embracing during a sadistic sexual encounter. Mechanism of death is anoxic anoxia.

Autopsy findings are acute congestion of the face, conjunctivae and skin of the chest showing a clear demarcation between areas above the level of pressure and one below. Ribs fracture at mid-auxiliary line or at the point of union with costal cartilage. Inter-costal muscles get bruised at site of pressure on the chest. Pneumo-thorax may occur and in such cases, its presence should be confirmed before opening chest cavity. At site of fracture of rib, lung may also show tear.

Autoerotic asphyxial death is a special form of sexual deviation, which is seen mostly in males of age between 18 to 25 years. Dead body is partially dressed in female clothes or other items of female use. Dead body is tied with ropes in a

complicated fashion with a noose around the neck and another around the penis. Neck is usually protected with a soft pad under the rope. Scene of incidence is usually an isolated spot. Overt sexual elements like pornographic material are present at the scene within visual range of the deceased. It is believed that such deviants being masochistic, transvestite derive sexual pleasure from such attempts. Death is accidental and takes place in an attempt to enhance orgasm, which ends life.

14. Toxicology verse Forensic Toxicology

Toxicology since earlier period of its history had been associated with word poison and also causing of criminal poisoning. Word toxicology has been coined from two terms, i.e. 'toxin' and 'logos', which means poison and its study. Its etiology from antiquity remained connected with two words 'toxic' or 'toxical' in reference to man's death, a meaning prevailed through ages. As legend goes, word toxicology also remained related with two *Latin* and *Greek* words *toxicum* and *toxilonom* again meaning poison and arrow-poison respectively, further having relation with crime of homicide, because primitive man used to kill their enemies with arrow-poison.

Over the years, study of this subject included its basic titles like identification of sources of poison, determination of chemical composition and properties, harmful effects on living beings (both human and animal) after ingestion, remedial measures for reversal of harmful effects and which body part and in what body organ/tissue it is stored, methods of isolation of poison from body organs, fluids (blood, bile and urine), laboratory testing for identity, quantity, fatal doses of poisons and period including preparation of laboratory results and their interpretation.

As regards sources of poisons, it was initially believed that they existed only in nature at large, remained associated with accidental poisoning only and its number was fortunately low. Suicide by poisoning was rather rare. Homicide by poisoning was almost unheard, possibly by some clever murderer, who would dare do it, when he was certain that once poison gets absorbed in the body would not be detected. (Table 14.1)

Table 14.1:

Sources of poisons in nature at large

- Earth and other materials within like arsenic
- Widely grown herbs/plants such as opium and datura
- Poisonous animals found over ground like snake and scorpion and below sea water such as poisonous fish

Historically recorded and known first case of homicide is that of Mr. **Jabir**, an Arab alchemist. He was able to prepare *arsinous-oxide*, a white tasteless and order-less powder having action to cause stomach pains and vomiting. These symptoms resembled disease of cholera, which was prevalent at the time and left apparently no traces in deceased

body. This white powder remained favorite murder weapon of Middle Ages.

Detection of arsenic from biological materials of dead body, which are collected during autopsy examination, is a medical problem. It requires assistance of chemists. Issue of detection of arsenic was a challenge, which was accepted by two types of authorities' i.e. medical doctor and alchemist. Some examples of few such authorities, who became famous, starting from earlier era when science was still at its infancy to current modern scientific stage is tabulated. (Table 14.2)

Table 14.2:

Famous alchemists

- Karl Wilhelm Scheede (1775), Swedish chemist detected white powder in corpses and the discovery encouraged others to continue research.
- Valentin Rose (1806), German chemist improved testing methods and was able to detect arsenic only immediately after death in walls of victim's stomach, which soon after disappeared.
- Joseph Bolavelure Orifile, French physician and chemist specialized in identification of arsenic and solved the mystery of vanishing arsenic. Later he got the title of *father of toxicology*.
- James Marsh (1836), an English chemist further improved arsenic detection method to the extent of its discovery in small concentration up to one thousand's of a milligram, a real breakthrough in arsenic detection.
- Modern method in detection of arsenic, thousand times smaller quantity than that can be detected by any chemical method is *neutron activation analysis* by using property of radioactive decay.

Impetus in research to find substitute of morphine, a narcotic drug which is habit forming pain killer and also a drug of addiction led to invention of synthetic substitute drugs. As a result, numbers of synthetic substitute poisonous drugs increased many folds. With easy availability of these poisons along with failing standards of law enforcement, increased cases of both accidental and criminal poisonings giving new challenges. Due to these circumstances, toxicology continued to grow in many directions and become a vast unmanageable subject.

Topic of toxicology now has since been divided into many of its sub-types, which are gradually attaining independent status as separate discipline having specific nature of work with still some overlap. For ready reference, only a few important sub-types are mentioned:

- General Toxicology
- Clinical Toxicology
- Environmental toxicology
- Forensic toxicology

1. *General Toxicology* deals with sources of poison, its chemical composition, properties, effects on living beings (human/animal), fatal dose and methods of isolation and detection in biological material. Job falls within the domain of chemist, who performs his duties in chemical laboratory.
2. *Clinical Toxicology* is study of harmful effects of poisons in living persons, methods to reverse these effects by medical treatment till full recovery. It is responsibility of medical specialist, who performs his duty in hospital setting.
3. *Environmental toxicology*, a corollary of industrialization, polluting heavily our atmosphere, causing ill health with harmful physical agents and precipitating incapacitation amongst population at large. Identification of hazard and its prevention falls within domain of community/preventive medicine.
4. *Forensic toxicology* deals with detection of cause of death in alleged fatal cases of poisoning with innumerable poisons, mostly indigenous in nature with unknown chemical composition and mostly no hint about identity of poison is available. It requires conducting of forensic autopsy including further examination of collected specimens. The task is confidential, legally authorized, involving maintenance of chain of custody of specimens and specifically requires purpose-built autopsy room and extensive analytical logistic.

It is all this, not above mentioned other sub-topics of toxicology, which stands included as allocated syllabus for subject of forensic medicine. It includes many serial undertakings by police and medical examiner and necessary for successful detection of identity and quantity of poison involved:

- Collection of alleged history of poisoning
- Forensic autopsy inclusive preservation of biological specimen
- Laboratory procedures to identify and quantify poison involved
- Fixation of forensic exhibit

Collection of alleged history of poisoning principally is duty of investigating police as **circumstantial evidence** at site of incidence. Question directed towards victim's family should be

to know any drug/medicine found at crime scene, route of administration, interval between intake and onset of signs and symptoms developed after intake of poison. (Table 14.3)

Table 14.3:

Expected drug/medicine at crime scene

- Left out items at crime scene:
 - i. Medicines (pills/powders) and drink/food used by victim
 - ii. Empties, container and vehicle in which poison processed, (cup, glass and syringe)
- Other items from victim's body:
 - A. Place of entry:
 - i. Stomach/intestine, if ingested
 - ii. Vagina/uterus, if applied locally (criminal abortion)
 - iii. Skin and underlying tissue, if injected (heroin)
 - iv. Lungs, if poison is inhaled (volatile poison)
 - B. Place of stay:
 - i. Temporary in most poisonings (blood, liver and bile)
 - ii. Stored permanently as in chronic heavy metal poisoning (hair, nails and bones)
 - C. Place of excretion through which poison eliminated (urine and feces)
 - D. Contaminated items with vomit, blood, excreta (garments, bed sheet and earth)

Medical examiner should carefully read above submitted information and any deficiency should be pointed out to police and got corrected before starting forensic autopsy.

Forensic autopsy inclusive preservation of biological specimen from body of deceased is done quickly 'with no time wasted' to avoid decomposition of biological material. Procedure involved grossly differs from clinical specimen collection, because of its own objectives to avoidance contamination, substitution or loss of specimens during its collection, packing into container and during transit to laboratory:-

Forensic specimen preservation is guided by following questions:

- i. 'What specimen'?
- ii. 'From which site'?
- iii. 'How much quantity'?
- iv. 'What preservative used'? and 'What precaution'?

Besides above information's, specimen preservation requires information about quality of specimen, size of container and type of its stopper, manner of placement of specimen within the container, its labeling and method of sealing of container.

Before start of preservation process:

- i. Reasonable number of various sizes glass containers/bottles with wide and narrow mouths having glass stoppers should be available.
- ii. They are thoroughly scrubbed with soap and hot water, rinsed, placed in dichromate-sulfuric acid cleaning solution for several hours, rinsed again in distilled water and dried.
- iii. Placement of each specimen is undertaken separately.
 - a) In case of viscera, it is weighed before taking specimen
 - b) Total quantity of its fluid should be measured in order that the determination may be quantitative.
- iv. Labeling of each glass container should have required information to identify the specimen fully and completely.
- v. Sealing of each container is under taken by wrapping it with heavy paper, tie its top and bottom with a cotton cord, seal applied over the knot with sealing wax and mark wax seal with some distinctive device in such a manner that tampering would be immediately become evident.

Original condition of biological specimen, during pending period prior to its analysis in laboratory without decomposition is maintained with use proper technique and good preservative. Preservative differs, whether preservation for chemical analysis, histopathology, serology or as a museum specimen. Some mention is also made about vehicle used as "preservative" and as "fixative". Vehicles of preservation are:

- Rectified spirit
- Saturated sodium chloride solution
- Formalin for fixation.

Rectified spirit is a good and effective preservative for all types of viscera collected for chemical analysis, which are likely to decompose on keeping. Its use is contraindicated in poisoning by alcohol, phosphorus, acetic acid and carbolic acid.

33% solution of sodium chloride is an alternate good preservative vehicle. If concentration of sodium chloride is less, yeast and fungi, if present in stomach content cause fermentation of carbohydrate and produce ethyl alcohol and putrefying bacteria of intestine continue to grow and decompose organic matter and poisons particularly alkaloids and

glucocides. For detection of gaseous poison in blood such as carbon monoxide, sample should not be mixed with any preservative. It must be examined immediately before it starts decomposing.

Formalin is usual general purpose fixative and prepared by mixing one volume of commercial formalin with nine volumes of water. 10% formalin should always be neutralized by addition of precipitated calcium carbonate or finely divided marble, so that a layer one or two cm. deep lies at the bottom of the container. Fixatives for histology and preparation of blocks should be prepared in advance. After fixation for twenty-four to forty-eight hours, wash specimens in running water and store in 70% alcohol.

Laboratory procedures to identify and quantify poison involved will be discussed in a separate chapter later.

For guidance of medical examiners, he is advised to follow two of under mentioned set of legal instructions:

- **General instruction** (applicable to all specimens)
- **Special instructions** (applicable to each specimen)

General instructions

1. Source of the specimen should be beyond doubt.
2. Only authorized staff should collect specimen.
3. After collection, specimens should be stored in a freezer till processing.
4. Container of specimen should be impervious, clean and free from contamination.
5. Size of container should be adequate in relation to size of specimen.
6. Mouth of container should be appropriately wide to admit specimen.
7. Stopper of container should be screw-type to avoid leakage.
8. Every container should bear a label with the following entries:
 - Date and place of collection
 - Name of the specimen
 - From whom and from where collected
 - Type of examination required
 - Name and designation of person who collected specimen
9. Specimen should be properly sealed before dispatch.
10. If specimens are more than one, then each specimen should be identified with an identity

number and schedule showing identity numbers allotted to each specimen should be enclosed with forwarding letter.

11. Transportation of specimens to the laboratory should be done through the police official responsible for the investigation of the case.

12. If specimens are to be sent by post or rail, they should be either be registered or sent through prepaid railway parcel.

13. At time of receipt in laboratory, it should be ensured that seals are intact and related papers are complete in all respects.

14. Analyst should sign register to maintain chain of custody.

15. Receipt and registration of container should be done with the following entries:

Serial number of the year

Date of receipt of the samples

Bio-data of the victim

Date of medico-legal/autopsy examination certificate

Number and the name of sample

Place from where dispatched

Generally adopted routine in all poisoning cases needs mentioning of trios of viscera/ fluid preserved separately in super saturated saline in chemically clean glass containers, filled to two third of the capacity to accommodate gasses containers having screw type stopper:

i. a) Stomach and first part of intestines with contents/b) Stomach wash at least 500cc or entire quantity of first wash. Container capacity about 1000cc.

ii. Portion of liver, spleen and one kidney preserved together. Container capacity should be appropriate.

iii. Blood, bile and urine:

A. Blood besides poisoning, is also preserved for other reasons:

a) Determination of its source/personal identity problems especially paternity dispute for purposes of grouping taken simultaneously from child, his both parents who should verify each other's identity.

b) When collected from crime scene the quantity should be sufficient and when from an individual at least be 10-cc from a peripheral vein. Skin should not be cleaned with spirit while taking a sample for alcohol estimation.

c) 100 cc in poisoning case from right heart, specimen of choice in carbon monoxide and alcohol poisoning. Container special having a stopper to avoid loss of poison by evaporation. No preservative is used. Delay in dispatch avoided in cases of alcohol and carbon monoxide and bacteriological infection. The samples must reach the laboratory within a few hours and must be examined immediately, before they start decomposing. Self-sealing container is preferred.

B. Bile entire quantity is preserved for estimation of poison in it. No preservative is used

C. Urine is the easiest of all specimens to be preserved and is usually taken for estimation of alcohol and other poisons such as morphine, barbiturates, amphetamines and metallic poisons. It is also taken in cases of sexual assault to detect spermatozoa and gonococci. The entire quantity available is taken. For the presence of gonococci, it should be preserved in a chemically clean, sterile container and the sample should be sent to the bacteriologist immediately after collection. No preservative is used.

Preservation of other items than those referred in above trio of viscera:

1. *Clothes* are collected in cases of poisoning, physical and sexual assaults especially when soiled with vomit or stained by blood or semen. Preservation is done by air drying of the clothes by putting them on hangers. Weapon damage of clothes with knife or bullet (cut or whole) encircled, signed and photographed. Clothes /photographs placed in separate envelopes finally dispatched in plastic bag.

2. *Hair* is required in cases of chronic heavy metal poisoning and sexual assaults. In case of chronic heavy metal poisoning especially with arsenic and antimony, large number of hairs are cut from different parts of the scalp and put in an envelope. In sexual offences, if any loose hair is present on clothes, or body including pubic region, it should be isolated. If pubic hair is exuberant, the area is combed to isolate loose hair. Additionally two or three hair is also plucked with roots intact with the help of a tweezer to act as control. Sandwiching them

separately between glass slides and transparent adhesive tape preserves both loose and plucked hairs.

3. *Semen* is an essential material collected and preserved from body of the victim, stain of clothes, soiled bed sheet or floor/ground on two cotton swabs and two slides in cases of sexual assaults. When present on clothes, body of assailant or at places other than the vagina and rectal canal, it is usually in dried state and should either be scraped with a dry scalpel and collected on a glazed paper and then passed into a special container avoiding loss of the sample. Alternately the area may be moistened with saline and the material taken on a cotton swab attached on the end of an applicator. From vaginal or anal canal, it is taken before taking the urine specimen and before digital examination respectively. The material is received on a cotton swab attached to an applicator with the help of a suitable size, sterile, non-contaminated speculum. Careful withdrawal is necessary to avoid loss of specimen due to rubbing on the inner side of the speculum. Three swabs are generally prepared. Two are preserved by air-drying and placed in separate test tubes for dispatch to the laboratory. Third swab, while still wet, is used to prepare three slides. They are prepared after immediate withdrawal of the specimen from the vagina or anal canal by gently rubbing only once over the central portion of the slide. The film should be thin. Slides are also preserved by air-drying. The best two are selected and packed having smeared surfaces facing each other with two matchsticks between them placed near the free margin of the slides. The slides should be wrapped with adhesive tape to avoid displacement and loss of specimen. Both swabs and slides prepared accordingly are duly labeled and placed in a container, which is duly sealed and sent to the laboratory for identification of presence of spermatozoa.

4. *Saliva* is required for grouping purposes. After thorough mouthwash, about 5cc of saliva is collected by instructing the person to loosen his mouth letting saliva dribble out in a test tube. If necessary, the mucus membrane may be tickled with a glass rod. It is preserved by eliminating the food particles that are present in the saliva and also inactivating the enzyme amylase before its dispatch to the laboratory. The enzyme is

inactivated by indirectly heating the test tube containing the sample after placing it in the water bath for about 10-15 minutes. After cooling, the specimen is centrifuged at 2000-3000 revolutions per minute for 10 minutes. The food particles get settled at the bottom of the tube and the clear supernatant fluid is collected in a clean test tube.

5. *Nail clippings/scrapings* are needed in cases of poisoning with heavy metals, sexual assault and drowning. Nail clippings do not undergo putrefy, thus require no preservation procedure. They are preserved from free ends of nails with a nail-cutter into an envelope. In cases of sexual assault, non-consenting female inflicts scratching with her nails on the body of the aggressor, blood mixed with portions of the cuticle of his body gets deposited under her nails. Such nail scrapings are from the undersurface of the free ends of nails are usually preserved with the help of sharp pointed scissors or a scalpel and placed directly in a test tube. In case of drowning, contents of the water medium may get deposited under the nails. Label should mention the finger from where the specimen is collected.

6. *Bone and bone marrow* are required in heavy metal poisoning and drowning respectively. Two to three gm. of bone marrow is preserved in a container from the central part of a long bone, especially femur in case of drowning to detect the presence of diatoms. In cases of chronic poisoning by heavy metals like lead, arsenic and radium, 3-5 cm. of central segment of the shaft of a long bone is taken after dissecting the soft tissues. The segment is preserved as such in rectified spirit.

Safe custody of specimen is applicable to an organ, tissue or body fluid of victim and any recovery of foreign material like bullet. All those who hold custody of these materials have to declare on oath in the court of law that no tampering of evidence took place while in their possession. Person having custody of evidential material must hand it over only after obtaining a receipt. Persons involved in the possession of evidence form a **chain of custody** and a short chain is preferable. Responsibility of initiating *chain of custody* rests on medical officer, who collects specimen and must be able to state in the court:

- What was removed or recovered from victim's body?
- What was done with it?

- How long was it kept?
- Who was it delivered to?

Fixation of forensic exhibit is highly special job during preservation of forensic specimen for its display in forensic museum and later when required presented to court of law when asked for during court attendance. It has specific objective of achieving excellent fixation along with additional requirement to maintain original tissue color by some secondary means, because of its forensic nature.

Formaldehyde brings about conversion of hemoglobin to acid hematin, thus losing characteristic color of fresh tissue. In forensic exhibit of museum specimens, an attempt is made to prevent this discoloration. Tissues/specimens should be fixed according by two methods:

- **Kaiserling method**
- **Carbon monoxide method:**

Kaiserling method require Kaiserling solutions I, II and III.

Kaiserling I (formula):

Potassium acetate 170 gm
Potassium nitrate 90 gm
Commercial formalin 1600 cc
Water 8000 cc

After fixation in this solution for 3 to 7 days, specimen is thoroughly washed in running water for 12 to 24 hours and then placed in Kaiserling II solution.

Kaiserling II (formula):

95% ethyl alcohol

It converts acid hematin formed by the action of formaldehyde on hemoglobin into alkaline hematin, which is redder in color and more permanent than the acid hematin. Specimens should remain in alcohol from 6 to 24 hours, until there is full development of the natural red color. If ethyl alcohol is not available, tertiary butyl alcohol may be substituted.

On removal from the alcohol, specimen is washed in running water for about 2 hours, and placed in final mounting fluid, known as Kaiserling III.

Kaiserling III (formula):

Potassium acetate 172 gm
Glycerol 200 cc
Water 1000 cc

As a preservative, 20 cc of phenol or crystals of thymol are added until the solution is saturated. If

phenol or thymol is not available, arsenious acid 4 percent, or sodium fluoride 8 percent, may be substituted, and the potassium acetate reduced to a concentration of 2 percent. If glycerol is not available, propylene glycol is a satisfactory substitute.

Carbon monoxide method is fixation of specimens for 3 to 7 days in the following solution (formula):

Commercial formalin 100cc
Sodium Chloride 1 gm
Sodium bicarbonate 1 gm
Water 1900 cc

After thorough fixation, the specimen, with a sample quantity of fixative, is placed in a closed vessel through which illuminating gas may be bubbled. In the original fixation, the formaldehyde converted a part of the hemoglobin to acid hematin. The illuminating gas converts the remaining hemoglobin to bright red carboxy-hemoglobin. The gas should be bubbled through the specimen for 15 minutes each day until a satisfactory color is obtained. Care should be taken to see that the personnel in the laboratory are not exposed to the escaping illuminating gas. The specimen is then transferred without washing to the following preserving fluid (formula):

Sugar 40gm
Chloral hydrate 2 gm
Water 100 cc

If sugar is not obtainable, Kaiserling III with glycerol or propylene glycol may be substituted.

Before the specimen is sent to the museum, a note is made on the container in the protocol of the exact procedure used for fixation, restoration of color, and final prevention.

Additionally, some part of deceased's body such as odor during autopsy, some specific evidence within collected material may act as an indicator about nature of poison, and information should also be sent to analyst along with specimens. (Table 14.4)

Table 14.4:

Other poisoning indicators

- Presence of corrosion on lips, tongue or in throat or shreds of mucous in vomits indicate corrosive poisoning
- Odor discloses phenol, chloroform or preparation of crude opium poisoning
- Luminosity in dark of stomach washing and feces give evidence of phosphorus poisoning
- Presence of colored crystals of arsenic and mercury poisoning

When available information is only limited to route of administration and no information about identity, signs and symptoms or even fatal period of poison are known, following samples per table along with their quantity should be collected. (Table 14.5)

Table 14.5: Quantity of specimens for suspected case of poisoning

Specimen/Organ	Quantity
Hair	10gm
Brain	50(1 gm
Liver	500 gm
Kidney	One whole
Lung	One whole
Stomach	Whole with contents
Small intestine	Initial two feet with contents
Blood	50-100cc
Urine	all available

If probable diagnosis regarding identity of poison is available, choice of specimens is easier. Gastric and intestinal contents should always be taken for any poison taken by mouth when death has occurred within a few hours. Similarly, specimen of a lung should be taken for any inhaled poison. Chloroform, ether, alcohol and short acting barbiturates are not likely to be detected in materials taken during autopsy if deceased lived for several days following the ingestion. (Table 14.6)

Table 14.6: Choice of specimens

Nature of poison	Specimen
Alcohol, chloroform, ether, alkaloids and benzene	Brain
Fluoride, oxalate	Liver
Metal of mercury, lead, arsenic, radium	Bone
All gaseous poisons	Blood
Barbiturate, sulfonal	Urine

CHAPTER 15

15. Drug, Medicine, Poisoning and its Management

Drug, medicine and poison are three names given to chemical substances, which are loosely used for preparation of medicines (remedies) for medical treatment of patients' illnesses. Law preferred to use word 'drug' as its choice for both safe and dangerous drugs (poison) while framing respective legislations. Word 'medicine' is in common use both by public and medical practitioners. When word medicine is classed and formally recognized as proper medicine for illness, it has to have a safe dose, its benefits and precautions for use and a warning about its side-effects.

It is emphasized that when they are taken by self-medication or given by other, especially in larger than recommended dose, they harm individual acting as a **poison**. Poisoning is a concept of action of medicine/drug acting chemically and consistently to cause disturbances of both physiology and biochemistry of an individual, finally precipitating illness and even death.

Besides, there are few medicine/drugs, which have **potential for misuse**. It means use of drug apart from its medicinal use. There will, however, always be difficulty in deciding where use ends and misuse begins. This disagreement may even exist in medical profession. Classical example of such a disagreement is about use of sleeping pills especially in young people. Medicine having potential for misuse are stimulants like Coca, depressants like opiates (including synthetic substitute i.e. heroin) and others altering perception and mood like cannabis and mescaline. These medicines require much stricter control, because of the fact that even on medical grounds, they cause **drug addiction**, which eventually 'control the man' and also called **dangerous drug**.

World Health Organization laid criteria for diagnosis of *drug addiction* with further recommendation to replace word addiction with *dependence*. (Table 15.1)

Abuse of drug was initially tried to prevent by punitive measures:

- Arabs extract teeth of those guilty of chewing cannabis
- King James VI increased tax on tobacco by 4000%
- Catholic Church denounced use of coca

Table: 15.1:

Criteria for drug addiction (dependence)

- **Craving**---psychological dependant to continue taking drug
- **Tolerance**---needed amount increased for intended initial effect
- **Withdrawal symptoms**---discontinuation of drug leads to complex sequence of symptoms
- **Physical dependence**---body physiology functions only in the presence of increasing amount of drug
- **Social deterioration**---individual personality altered worst due to use of drug

Above measures did not yield positive results. Issue being complicated and of vital importance, it was taken up by *Assembly of League of Nations*. All participants resolved to take measure within their respective countries to suppress contraband traffic and abuse of drugs especially those derived from *Opium, Indian hemp and Coca leaves*.

What is important that these chemical substances called drug, medicine or poison should not be easily available in open market for public safety and should be controlled legally under license by Government over their manufacture, storage and sale/supply in such a way that their free availability to physicians as well as patients remains intact. India being state signatory had to introduce legislation of **Dangerous Drug Act 1930**, which was inherited by Pakistan in 1947 at the time of partition of India.

Dangerous Drugs Act 1930 and *rules/regulations* framed there-under empowers Federal Government to control cultivation, manufacture, import, storage, sale/supply of dangerous drugs. Relevant important dangerous drug rules to medical and dental practitioners are:

- Rules 8** (sale/supply),
- Rules 13** (quantity limitation)
- Rules 14** (record maintenance).

Medical and Dental Practitioner (RMP/RDP) are advised to carefully go through and abide by them in letter and spirit during medical practice.

Rules 8:

1. A licensed chemist can sell opium alkaloid or coca derivatives to RMP/RDP known to him or other person holding a prescription subject to following conditions:

- RMP/RDP should either sign register in person or send a written signed order stating his name, registration number, address and name and quantity of drugs required
- Licensee shall satisfy himself as to genuineness of signature and qualification of medical practitioner
- If drugs are to be obtained by post, they shall be sent by registered post
- In real emergency, drugs may be supplied on oral message, provided licensee is satisfied about genuineness of oral order and medical practitioner assures to provide written signed order within 24 hours

2. Drug supply to other person having a prescription is subject to following conditions:

- Opium alkaloids or coca derivatives shall be sold in such quantity only as may be specified in prescription
- If prescription does not bear a **superscription**, dangerous drugs shall be sold once only and prescription shall be retained
- If prescription bears a superscription, chemist shall make entries about amount of drug supplied, date of sale, sign and apply seal on prescription before returning it to the holder
- If it appears from the prescription that dangerous drugs have already been sold *six times* or *such number of times* as prescription required to be repeated, he shall not sell dangerous drugs on such prescription

Rules 13:

1. RMP/RDP may possess DDs for *use in practice** at any one time:

- Medical hemp..... 3 ounces
- Medical opium..... 3 ounces
- Opium alkaloid derivatives(excluding prepared opium)..... 60 grains
- Coca derivatives..... 60 grains

*'Use in practice' covers only direct application of drugs in injection, surgical procedure or other emergent cases by or in presence of the registered medical practitioner.

2. All other issues/distributions of drugs by him or from his dispensary will amount to sale for which he must take a chemist license.

Rules 14:

1. RMP/RDP shall maintain record of DDs in separate registers for each drug or in separate parts of same register assigned to each of following classes of drug/preparations:
 - Cocaine and its preparation

- Medical opium
 - Morphine and its preparation
 - Morphine derivatives and its preparation
 - Extracts or tinctures of Indian hemp
2. Entries in register shall be made on day on which a drug is received or dispensed. **
 **It is not necessary that RMP/RDP make entries himself in register of particulars of drugs administered by him or under his supervision but entries must be verified by him on following date.
 3. Where RMP/RDP practices at more than one premises, separate amounts of drugs shall be kept and maintained at each premise:
 - Every entry required to be made and every correction of such an entry is made in ink.
 - No cancellation, obliteration or alternation shall be made of any entry in register and if any correction of an entry is made, it shall be made by way of a marginal note or footnote and entry shall specify date on which correction is made.
 4. Record of DDs in possession of a RMP/RDP is open for inspection by officers' not below ranks of District Health Officer and inspector of Excise Department.
 5. RMP/RDP should submit information about transaction of DDs as may be demanded from him and all record including registers and daybooks are to be retained for two years from the date of last entry.
 6. RMP/RDP shall keep DDs under lock and key, take proper precaution for their safety while carrying such drugs to house of patient and report theft or loss to nearest police station immediately.

Dangerous Drug Rule has further been amended for immediate implementation:

- i. Increase severity of punishments like death penalty and confiscation of property of those who indulge in contraband traffic of these drugs
- ii. Improve existing measures of medical treatment of drug addicts by establishment of drug addiction treatment center in psychiatric wards of government hospitals.

None of the measures taken so far has improved the situation. Materialistic pursuits have corrupted all those who are responsible for imposing checks against misuse and contraband traffic. Criminals have continued to devise new methods of transportation, especially **heroin** from one country to another. **Human carriers** have been introduced, who ingest capsules of heroin to conceal them. Covering of capsules containing heroin may get dissolved liberating it into intestine, from where it gets absorbed

into blood circulation and precipitate death of the carrier. (Photo. 15.1)

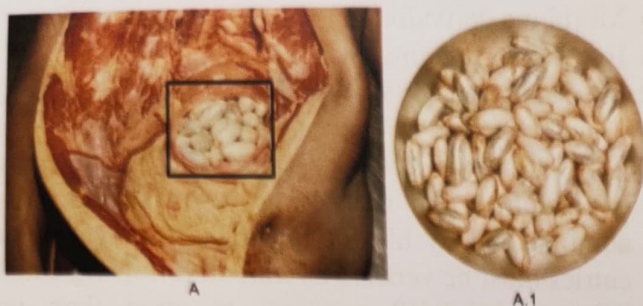


Photo 15.1: A. Dissected intestine containing capsules filled with heroin. B. Total quantity recovered

Contraband traffic and misuse of these drugs continued even after enhancement of punishment. Rather, use increased manifold to the stage resulting into grave threats to survivability of the society. Solution is to accept command of Allah, Who ordained fourteen hundred years ago that addiction of all kinds is haram and His obedience is the last hope.

Other legislation of medicine is *Drug Act 1940*, which after few years of its imposition was replaced with **Drug Generic Name Act**. Currently operative act is **Drug Act 1976**.

Drug Act 1976 is modern, more exhaustive and has been introduced incorporating World Health Organization (WHO) recommendations providing guidelines in respect of quality of marketed drugs. Further rules/regulations for its implementation have been framed. Act. Registered Medical practitioners are advised to go through it, familiarize themselves with relevant sections and rules/regulations, especially those dealing with registration and import of drugs from other countries. (Table 15.2)

Table 15.2:

World Health Organization recommendations

- Marketed Drugs (produced locally) adequately tested for required quality
- Locally produced and imported drugs registered before marketing
- New drugs evaluated for safety and efficacy for intended use before introducing
- Medical practitioners kept fully informed about (desired/undesired) properties of drug
- Proper control over advertising of drug to prevent or discourage misuse by medical profession

Registration of drug being duty of Federal Government is done by Registration Board consisting of seven members and additionally constitutes three standing sub-committees on drug evaluation, preparation of national formulary and control over advertisement or any other. (Table 15.3)

Table 15.3:

Composition of Registration Board

- Director General, Health, Government of Pakistan (Chairman)
- Deputy Director General of Health
- Professor of clinical subject
- Professor of pharmacology
- Pharmaceutical Chemist
- Medical Specialist, Army medical Corp
- Member from Drug Administration (Secretary)

National formulary is comprehensive list of locally manufactured and imported available drugs with their strength and recommended dosages for information of medical practitioners. After its preparation, it is notified in Extra-Ordinary Gazette of government of Pakistan.

Central licensing board of Federal Government issue import license for drugs from abroad. (Table 15.4)

Table 15.4:

Composition of central Licensing Board

- Director General Health, Government of Pakistan (Chairman)
- Members (two) Secretary, Provincial Health Departments (Punjab and Sind)
- Members (three) each conversant with:
 - Pharmaceutical profession, (Khabar Paktoon Khawa)
 - Medical Profession (Baluchistan)
 - Drugs' administration (Federal Government), who act as ex-officio secretary of the board

Poisoning and its medical management, whether received by family physician or in hospital setting is principally responsibility of specialty of medicine. All acute poisoning cases are clinical medical emergencies situation at both places and should be dealt with on general principles of management, demanding urgency and use of common sense irrespective of causation. Medical treatment should be symptomatic, because such patients respond quite well on these lines. Advice from senior colleague in hospital should be taken in difficult cases especially when a commercial preparation is ingested and contents are not revealed on the label. The assumption that a tablet found in a container that is lying near the patient is drug ingested may not be correct. Quite frequently, more than one drug is taken.

Most cases are accidental poisoning consisting mainly of *self-medication*, even *therapeutic misadventure* as in addiction and abortion. Patient invariably is unconscious and comatose. First relevant question asked from patient's attendant is whether he has left any note or a medicine at the place of his recovery. Real cause may be some disease. While dealing such cases, bacterial food

poisoning must be distinguished from toxic reaction due to contamination by metal such as arsenic or lead or due to toxic vegetables like fungi, mushrooms and food allergic reaction due to eggs, shellfish or strawberry.

Besides accidental emergencies, there are others types such as industrial, suicidal or homicidal poisoning. These cases additionally require forensic certification and collection of specimens for confirmation legally of poison involved. Family physicians and private sector hospitals are generally reluctant to accept medico-legal emergencies because of follow-up court attendance. Such emergencies are thus accepted and admitted by public sector hospitals and also better managed as shared responsibility between forensic medical examiner and medical registrar of clinical medicine. Clinical management require in a general way following related knowledge about poison:

Route of entry mostly is gastrointestinal tract gaining entry through mouth, followed by respiratory channel and skin both intact and broken inclusive of injections. Other rare channels of entry are vagina, rectum and bladder.

Action on patient's body depends on method of administration and personal response. Age and disease may modify this action. Tolerance develops in addicts. Personal sensitization or development of allergic reaction is an important factor as regards rapidity of action or even death. Characteristics of

Table 15.6:

Poisonings and diseases causing similar signs and symptoms

Symptom	Poison	Disease
Vomiting	Aconite, alcohol, antimony, arsenic, barium, cantharides, colchicum, copper, corrosives (acids and alkalis), digitalis, fluoride, iodine, mercury, phenols, phosphorus and zinc	Acidosis, brain tumor, cholera, early pregnancy, gastric and duodenal ulcer, gastritis, enteritis and uremia
Coma	Alcohol, atropine, barbiturates, carbon monoxide, carbon dioxide, chloroform, chloral, cyanides, hyoscine, opium, and its alkaloids and derivatives, paraldehyde, phenol, sulphonal	Acidosis, brain diseases and injuries, cerebral embolism hemorrhage and thrombosis, eclampsia, epilepsy and uremia
Dilatation of pupil	Belladonna and its derivative, cocaine, hyoscyamine, nicotine, stramonium	Causing optic atrophy or oculo-motor paresis, sympathetic irritation
Contraction slow	Derivatives of opium, mescaline, physostigmine, pilocarpine	Diseases of central nervous system
Rapid respiration	Carbon monoxide, derivatives of opium, hypnotics	Compression of brain (any cause), uremia
Delirium	Atropine group, carbon dioxide and cocaine	Respiratory diseases, hysteria and lesions of medulla
Dyspnea	Atropine group, cannabis indica, cocaine	Delirium tremens, encephalitis, epilepsy, insanity, meningitis, nephritis, organic brain diseases
Cyanosis	Carbon monoxide, cyanides, strychnine (during convulsion)	Lesions of medulla and vagus, cardiac and respiratory diseases
	Aniline, nitrobenzene and opium	Lesions of medulla and vagus, cardiac and respiration diseases, prolonged convulsions, diseases producing cardiac embarrassment

allergic reaction are skin rash, urticaria, flushing, edema of glottis, nausea, vertigo, dizziness. Vomiting may finally precipitate electrolyte imbalance and death.

Sign and symptoms, which develop in many poisonings, may be identical with those caused by diseases. It must be borne in mind that unusual symptoms may be produced in an individual by various poisons just as unusual symptoms may occur in any disease. Differentiation is difficult and as an aid for differentiation, a list of symptoms common to both poisoning and disease is given with a rule to differentiate acute poisoning from disease. (Table 15.5 & 15.6)

Table 15.5:

Rule to differentiate acute poisoning from disease

- Symptoms appear suddenly when patient is in good health.
- Makes appearance after taking of food, drink or medicines.
- If several persons take same food or drink, all will show similar symptoms.

Identification of used drug should be attempted visually by noting marking, color and shape of tablets or capsules. Presence of a drug in gastric aspirate, blood and urine provides definite laboratory diagnosis.

Diagnosis of acute poisoning is based upon the principle that easily available and commonest drugs are usual choice. Drugs prescribed by family physicians are usually taken. Elaborate testing is unnecessary. History and circumstantial evidence should make it possible. Some information regarding medication for any illness may come from family physician. Further, few drugs cause specific symptoms. (Table 15.7)

Table 15.7:

Drugs causing specific symptoms in acute poisoning

- *Opiates* produce vomiting, pinpoint pupils, slow and shallow breathing, unconsciousness ending into coma and death.
- *Salicylates* intoxication does not affect consciousness, patient has flushed face and suffers from tinnitus, deafness, raised body temperature, sweating and over breathing.
- *Barbiturates and antidepressants (tricyclic)* over-dose usually produce symptoms of deep coma and show skin blisters which appear on parts of the body liable to friction and pressure.
- *Addicts* show vein puncture marks on the back of hands, front and back of forearms, in cubital fossae and inner aspect of calves. These puncture marks may be concealed with tattoo marks.

Removal of unabsorbed poison from stomach is essential and should be done quickly:

- Using *emetics* to induce vomiting. Apomorphine cause projected vomiting and shock. Syrup ipecac has its advantage, but there is delay of 18 minutes with it, which is immaterial.
- Gastric lavage* is best done by having patient in hospital. If patient has swallowed less than 10 tablets, procedure is unnecessary. Mental trauma and risk of inhalation of material into lungs especially in children are great. In unconscious patient cough reflex is already absent.

It is first thing to be done on receipt of patient in hospital. Speed is essential. It is done nearly in all cases of ingested poison except when contraindicated as in poisoning by corrosive. Normal emptying time of stomach is 4-6 hours and the view that stomach wash is undertaken only in first 4 to 6 hours of drug taking is not correct. It should be done even after vomiting, which supposedly have removed all stomach contents.

Stomach tube is composed of a flexible rubber about 40 inches (1.5 meter) in length and about 1/2

inches (12 mm) in diameter having two terminations. Upper end has a filter funnel and lower termination is rounded and has three or four perforations. There is a mark at 20 inches (50 cm) from the lower end. Average distance between mouth and cardiac end of stomach is 18 inches (45 cm), therefore, tube must not be pushed in beyond this mark. Stomach wash is performed using tube of appropriate size to age of patient, which is passed through mouth and stomach contents received using warm water into the receptacle. In babies, it is best to use saline. (Fig 15.1)

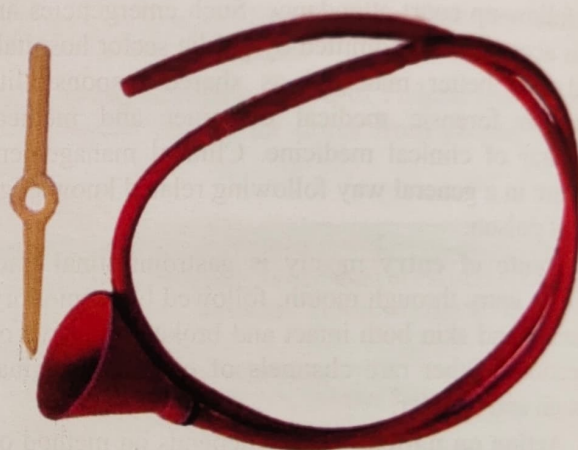


Fig 15.1: Stomach tube with wooden mouth gag

Unconscious patient is placed on the table in prone lying position with his face downward hanging over the end of the table. Pharynx of patient in this position would be at a lower level than the larynx and trachea and fluid leakage or regurgitation into the larynx does not occur in this position. The tube, after lubricating only the lower end, is passed first through the mouth gag and then into the mouth.

Extreme care is exercised to guide tube into pharynx and esophagus by placing two fingers well back over base of tongue. Slide tube along these fingers up to mark on tube, put wooden mouth gag in position and hold tube with one hand to avoid slipping of tube out of the mouth. Funnel end is raised above the level of the stomach and about a pint of warm water is poured into the funnel to run it into the stomach. Sooner the funnel is empty, the tube at its junction with the funnel is pressed between finger and thumb and the funnel end lowered below the level of the stomach into the receptacle. The pressure of the fingers is released. By siphon action, the contents of the stomach mixed with water will pass out through the tube into the container.

For a complete wash, about two gallons of water should be used, every time about one to one and a half pints. First wash is done with pure water and the washing is retained for analysis. Subsequent wash is done with suitable chemical antidote and the last wash fluid is allowed to remain in the stomach to neutralize the poison. There are few occasions, however, where specific solutions are indicated. (Table 15.8)

Table 15.8:**Chemical antidote for specific poisoning**

Chemical antidote	Poisoning substance
Desferal	Iron
Water and castor oil	Doriden tablets
Potassium permanganate	Opiate
Activated charcoal*	Salicylates

* (within 30 minutes of ingestion)

Elimination of absorbed poison is mainly through kidneys. Giving saline and stimulating kidneys with diuretics generally removes absorbed poison. Quick removal of the poison from the body is achieved with **forced diuresis** especially in poisoning with salicylates and amphetamines. **Peritoneal and renal dialysis** is indicated in poisoning with barbiturates and lithium salts. Specimens most commonly collected in the living victim of acute intoxication, besides stomach wash is *drug left over at the scene, blood and urine*.

Antidote therapy should be considered whenever necessary. Antidote counteracts the action of a poison by either neutralizing it or making it insoluble or inert. The administration of an antidote is generally indicated when the poison is still in the stomach. It should also be used after emesis or gastric lavage to neutralize the residual poison and even if a route other than ingestion is used to administer poison.

There are two types of procedures for anti-doting a patient of poisoning: **generalized procedure** and **specific antidotes**:

- **Generalized procedure** exists for non-specific anti-doting of most poisons:

(a) Ingested poisons are successfully removed either by emesis, gastric lavage or by adsorbing onto activated charcoal.

(b) Inhaled poisons are treated with oxygen therapy

(c) Skin contamination by washing with soap and water.

Dilution of the ingested poison is an initial recommended procedure and water is the best and

indeed the only fluid, which is used especially when the identity of the poison is not known. A rule of thumb, often stated, is to administer one to two cups-full to a child and three to five cups-full to an adult. As the gastric mucosa is a secretory and not an absorptive surface, the diluted poison is not likely to be harmful. Excessive quantity of water, if given, will distend the stomach wall and cause premature relaxation of pyloric sphincter, allowing the gastric contents into the duodenum. Once this happens, the poison begins to be absorbed immediately and it becomes difficult to remove.

- **Specific antidotes** are available and can be classified into the following types:

(a) Chemical antidote reacts with the poison chemically either to neutralize it directly or to produce a compound of lesser toxicity. The examples of former variety are weak alkalis and acids and the latter type are calcium salts. Calcium salt administered in case of oxalic acid poisoning reacts with it to yield poorly soluble calcium oxalate, which largely passes through intestine without being absorbed. Another good example is potassium permanganate, which is effective against all poisons capable of oxidation. It is used in strength of 1 % solution and about 100-150 ml should be left in the stomach in cases of poisoning with barbiturates, cyanide, opium and phosphorus.

(b) Physiological antidote acts physiologically on biochemical systems producing effects opposite to those produced by the poison. Example is chlorpromazine for the treatment of amphetamine overdose. Agents like diazepam or barbiturates, however, are now considered far safer for sedation than chlorpromazine.

(c) Receptor antidote is a substance, which competes with the poison at the same receptor site and reduces undesired effects. Examples are naloxone and atropine sulfate.

Naloxone is a pure narcotic antagonist and is the recommended drug of choice for reversal of overdose cases of narcotic analgesics, particularly in the presence of respiratory depression, coma and convulsions. It is superior to nalorphine, which was used previously. It is also effective against synthetic agents. Recommended dose is 0.01 mg/kg body weight intravenously, intramuscularly or subcutaneously in children and 0.4-0.8 mg/kg body weight in the adults, repeating the dose at two or three minute intervals for three doses. However, in severe cases a much larger dose may be required.

Atropine sulfate is a parasympatholytic agent, which effectively blocks the effects of acetylcholine at the neuroreceptor site. The drug is indicated in the treatment of symptoms of poisoning with organo-phosphate insecticides and other cholinesterase inhibitors such as physostigmine salicylate. In the case of organo-phosphate poisoning, a test dose of 2 mg intravenously should be administered in adults. The dosage of atropine sulfate must be increased and repeated frequently until cessation of secretions is observed. Very high doses have been used in such insecticide exposures.

(d) Mechanical antidote is a substance, which makes the poison inert by its mechanical action while it is in the stomach. Examples are egg albumin, oils and fat.

Irrational antidote therapy should be discouraged. The use of analeptic agents or central nervous system stimulants such as nikethamide is not considered useful in overdoses with central nervous system depressants. These agents produce no change in mortality rate or the duration of coma, but may actually worsen an already grave clinical condition by producing convulsions, arrhythmia and psychoses.

(e) Universal antidote comprising of charcoal, magnesium oxide and tannic acid is a myth and has no place in the management of toxicity. It is less effective than activated charcoal alone in its adsorptive and antidotal value. Tannic acid is a known hepatotoxic agent.

Medical management of acute poisoning requires shifting of patient to the nearest hospital as soon as possible. Send all available information at the scene with the patient. On receipt of the patient in hospital, medical treatment remain the same, but the methods adopted become more sophisticated such as intra-tracheal intubation, tracheostomy, mechanical respiration and administration of respiratory and cardiac stimulant. The following principles are adopted; maintain the airway clear, assist pulmonary ventilation, give oxygen when necessary, treat shock and pain and sedate if the patient is convulsive.

Assessment of patient's condition, regarding severity of acute poisoning should be done clinically from degree of coma, depth of respiratory depression, extent of shock and hypothermia. There are four stages of coma:

- *First stage*, patient is drowsy, but responds to vocal commands
- *Second stage*, he is unconscious, but responds to minimal stimuli

- *Third stage*, his unconsciousness deepens, but the patient responds to painful stimuli
- *Last stage*, unconsciousness is such that there is no response whatsoever.

Needless to stress that for the diagnosis of coma, reaction of pupils to light has little value. Correction of respiration by administering respiratory stimulants usually ends in disappointment. Tracheotomy is not usually needed. *Most important step is to keep the airway clear from the moment the patient is first seen till recovery.* All those involved with the case, both outside and inside the hospital must ensure that patient has a clear airway. Oxygen should be given, but mere administration of oxygen is no excuse for neglecting of ventilatory attention.

Correction of shock and hypothermia are essential steps. A significant hypothermia exists in all poisoning cases and it contributes to shock, acidemia and hypoxia. Best way to treat hypothermia is to raise the temperature of inspired air. Maintaining of tissue perfusion especially of brain, heart, lungs, liver and kidneys would treat shock. Tissue perfusion is very difficult to measure. Traditionally blood pressure is taken as a reasonable guide. If systolic blood pressure is below 80 mm Hg, steps should be taken to improve circulation. Raising foot of bed, aramine 5 mg intramuscularly at 20 minutes interval and correction of acidemia by infusion of bicarbonates can do it. Other measures include infusion of fluids and correction of electrolyte. An infusion of 1500 cc. in 24 hours is usually adequate. It is necessary to check urine flow. Catheterization may be necessary. It has risk of introducing infection. Chance of recovery from severe over-dose is dependent on good nursing care. Prophylactic antibiotics for patients having a raised body temperature are necessary.

Medico legal implication in majority of cases is that most cases of poisoning either are accidental or suicidal. Drug over-dose patients usually suffer from anxiety, depressive illness or personality disorder and last types are adolescent maladjustment behavior and therefore, need *psychiatric assessment and counseling* for social adjustment.

Murder by poisoning is rare, but when it happens is quite sensational. It is good to be suspicious about poisoning cases and family physician including casualty medical officer should be alert to this possibility.

Drug over-dose incidences and accidental poisoning can be controlled and even prevented by storing the medicines and chemicals having potential

for poisoning in locked cupboards. They should be out of reach of children and not being seen by them. For adults, it is a much more complex problem, which involves changing an accepted pattern of social behavior. Medical profession can do a lot by prescribing less and warning patients about dangerousness of drug abuse.

Trend of over-doses is changing now towards tranquilizers, antidepressants and non-barbiturate hypnotic. There is a tendency now to take more than one drug at a time and most common combination being a tranquilizer and an antidepressant or a hypnotic usually a non-barbiturate.

True suicide case needs thorough investigation. The scene of suicide should be examined before it is disturbed. Scene offers strong indication of motive of death. *Empties or partially empty bottles and pillboxes* may be found lying by the side of the deceased together with a glass or some other drinking utensil like cup or glass. Glass or cup may have *well defined crystalline deposit* not only in the bottom, but also around the sides. Partly dissolved tablet or capsule may also be present. *Suicide note* or a recently written letter especially if one is addressed to a near relative provides indisputable evidence of motive. Occasionally, a dropped tablet is found giving the first indication of poison taken and the cause of death. Personal effects may reveal the presence of great quantities of miscellaneous drugs.

Most of the drug taking *by habitual* is usually done indoors, but a certain number of cases occur in open. Those who take drugs outside choose a place of at least partial concealment. After taking of drug, he may wonder about in disoriented or semi-comatose state or he may unclothe himself especially after alcohol and datura and in such a case suspicion of assault may arise.

In addicts, death usually occurs out-doors. Most striking feature of such cases is *deterioration in the habits and behavior* of the addict. Normally accepted standards of personal cleanliness and hygiene are absent. Entire place is in a state of disorder. Articles of clothing and utensils both cooking and crockery are kept very dirty and all over the place. *Feces, urine and vomit*, may be found together close to the deceased. "*Empties*", *hypodermic syringes* and *needles* are always found all over the place. Sometime thick mould is found grown over dirty crockery.

Autopsy findings in death due to (i) **hypnotic** are an intense cyanosis and marked appearance of

petechaeal hemorrhages in the skin. Distribution of these hemorrhages frequently is so profuse that the case may resemble mechanical asphyxia. Bullas may appear on the parts of the body liable to friction and pressure and these bullas occur when the death is delayed for many hours. They also occur in CO, opiates and nitrobenzene poisonings. Crystalline material may be present at the lips or in the mouth. A quantity of frothy mucus is often expelled from the mouth after death. In case of (ii) aspirin, vomit soils clothes. An *addict* body is emaciated and has puncture marks at the usual sites.

CHAPTER 16

16. Specific Poisons

While describing a specific poison, it is important to include its necessary aspects such as source, form and preparations, mode and site of entry, route within body after absorption, mode of action, resultant sign and symptoms, fatal dose/period and category of poisoning like acute, sub-acute or chronic. Further specific poisons having similar properties are grouped for convenience of understanding and remembrance.

Important groups such as heavy metals, alcohols, barbiturates (synthetic derivatives of urea) and Poisonous plants are discussed one by one.

Heavy Metals of forensic importance are arsenic, lead and mercury.

Arsenic metal is harmless, but its prepared compounds are toxic. Term arsenic and arsenal compound is used loosely for all compounds containing element of arsenic. Organic compounds are less toxic than inorganic. Arsenic salts are extensively used in industry, agriculture, animal husbandry and even medicine. Preparations of arsenic are present in print sprays, weed killers, insecticides, rat poisons and fly paper. Arsenic is also used in the manufacture of colored wallpaper, artificial flowers, candles prepared from wax and in confectionery. These preparations may be misused for criminal purposes.

Poisoning sources include soil having arsenic as a natural constituent and verity of **crustacean's shellfish**, which is found in sea water. When it is taken in diet and it results in excretion of arsenic. In view of presence of arsenic in soil as a natural constituent, whenever an exhumation is undertaken in suspected case of arsenic poisoning, soil samples from above, below and from a site distant from the place of burial are recommended. (Photo.16.1)



Photo.16.1: Crustacean shellfish varieties

Absorption of arsenic salts is through the mucous membrane of the intestine when ingested. Arsenal dust and arsine gas is absorbed through lungs by inhalation. When an ointment containing salts of arsenic is applied over the skin, it gets absorbed.

Fatal dose of arsine oxide is from 1 to 3 gr. Use of salts over long period produce tolerance and larger doses may be tolerated.

Storage of arsenic salts occurs principally in liver, kidneys, hair, nail and bones in acute poisoning, but even distribution takes place in the tissues in chronic poisoning. Hair, nails and bones store it for longer periods and permanently, thus it can be detected easily by analysis.

Mode of action of arsenic and arsenal compounds is both local on the intestinal mucosa, which gets irritated and remote on body organs after absorption. It inhibits intracellular enzyme activity and causes disruption in oxidative mechanism and intracellular respiration. Small doses produce mild vasodilatation, whereas large doses precipitate transudation of plasma, reducing blood volume and produce clinical shock. It also depresses cardiac muscle directly, which aggravates the shock. Bulk effect of transudes into the lumen of small intestine together with mucosal irritation and damage stimulates peristalsis leading to characteristic *rice-water stools*. Tubular necrosis of kidneys is partly due to shock and partly due to local direct action. It results in oliguria, hematuria and proteinuria. Bone marrow activity gets depressed. Arsenic salts enjoy a vogue in the treatment of leukemia.

Acute poisoning is not rapidly fatal. Immediately after ingestion, there is metallic taste with burning sensation in the mouth and throat. Abdominal pain, nausea, vomiting, bloody diarrhea and shock follow. Hemorrhage may be profuse. Cramps in limbs may also occur. Death occurs within a few hours due to circulatory collapse.

Sub-acute poisoning manifests pain in the muscle, intense thirst, anuria and gross electrolyte disturbances. Convulsions may occur before death. A-plastic crises showing red cells with *basophilic stippling* as many coarse blue-purple staining granules within the red blood cell and immature red and white cells may later express effect of arsenic on the bone marrow. Deposits of arsenic in growing part of nail become visible as white horizontal streaks

called *Mee's lines*, after episodes of poisoning with arsenic, thallium or other heavy metals. They can also appear if the subject is exposed to chemotherapy and suffering from renal failure. They are typically white bands traversing the width of the nail, as the nail grows they move towards the end and finally disappear when trimmed. (Photo 16.2 & 16.3)

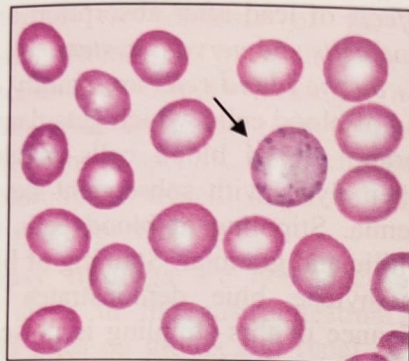


Photo.16.2: Slides of red blood cells with one single cell showing basophilic stippling



Photo.16.3: Mee's lines on central three fingers

Chronic poisoning is a classical state of ill health and patient is usually wasted. Main clinical features are loss of appetite, vague nausea and occasional vomiting with loss of weight, general malnutrition and anemia. Inflammation of the upper respiratory tract leads to sneezing, hoarseness and stomatitis. Breath has smell of garlic. There may be edema of eyelids and ankles, loss of hair and peripheral neuritis with tingling paraesthesia in hands and feet. It had been initially known that arsenicosis i.e. chronic arsenic environmental pollution through drinking water cause keratosis to skin of hands and feet, which shows yellow-brown pigmentations. (Photo 16.4)



Photo.16.4: Showing yellow-brown pigmentations to skin of both hands

Arsenic poisoning association with cancer has been claimed since 1820:

- Recent report claims an eight-fold increase in the incidence of respiratory cancer in smelting workers.
- Environmental epidemiological hazard noticed in three epidemics of skin cancer due to contaminated drinking water with arsenic in Silesia, Argentina and Southwest Taiwan.
- Prolong use of medicinal arsenic has been reported to cause iatrogenic cancer in lung (Robinson 1963), hemangio-endothelial sarcoma (Regelson 1968).

Medico-legal implication of arsenic poisoning is that *white* and *yellow* arsenic has history of being homicidal poisons. Criminal poisoning by arsenic is becoming rare, but occasionally cases still do occur and cause sensation. Rarity of occurrence should not make the medical practitioner forget this possibility. They are easy to obtain, tasteless, efficient, delayed appearance of symptoms of poisoning due to latent period and victim travels some distance before death and the situation simulate cholera. Embalming fluids contain arsenic and once the victim is embalmed, the evidence can get obscured. (Table 16.1)

Table 16.1:

Differential features of acute poisoning of arsenic from cholera

Features	Acute poisoning	Cholera
Burning in throat	Before vomiting	Not so
Vomiting	Contains mucous, bile and streaks of blood	Watery
Stools	Deep colored, bloody discharge having whitish staining	Rice-water
Voice	Rough, whistling	Not affected
Conjunctiva	Inflamed	Not affected

Suicide by arsenal preparations is on record by taking weed killers. Accidental poisoning occurs with arsine gas. It causes hemolysis and according to **Hunter**, it is very dangerous poison, which can kill outright.

Autopsy findings:

- *Acute poisoning* findings are that stomach and upper part of the small intestine are highly inflamed. The mucous membrane has a typical velvety appearance, buffed up by inflammatory edema. Stray particles of white oxide may remain adherent to the walls causing erosions in the mucous membrane and bleeding from erosions may

tinge the vomit. The liver shows fatty degeneration, less frequently jaundice with necrosis of liver. Heart muscle and kidney parenchyma show similar acute fatty degeneration.

- **Chronic poisoning** findings are that decomposition is retarded. Retardation is not due to presence of arsenic. Delay in the onset of putrefaction is due to dehydration caused by long standing absorption of the poison. It will produce loss of flesh. There may be anemia, fatty degeneration in heart, muscles, liver and kidneys. Microscopically, peripheral neural degenerative changes may be seen. Skin shows pigmentation of keratosis.

Materials collected for analysis when the victim is alive are vomit, stomach wash, urine, fecal matter and blood. Hair, nails and bones in addition to the above samples when dead.

Lead and its salts are used in more than 200 industries. As compared to arsenic, lead salts are more important owing to its massive industrial use causing accidental and chronic poisoning to workers and public.

Poisoning sources is lead acetate, which in combination with morphine is used in the preparation of lotion for use as astringent and local sedative. Workers are exposed to lead fumes and dust from furnaces, smelting trade, in electric accumulator, burners to weld terminals, in motorcar industry, portable disc grinding and many more trades. Accidental poisoning with white lead has been happening in children by drinking contaminated water.

Absorption of lead salts takes at three places:

- Skin when a lotion having these salts is applied over it
- Through lungs, if fumes are inhaled
- Oral route after ingestion and swallowing of dust or contaminated food or drinks.

After absorption from small intestine, it passes to the liver and excreted back in bile into the duodenum from where it is re-absorption. It goes to blood via portal circulation, when fumes are absorbed from respiratory tract. It rapidly enters systemic circulation and produces its full effects.

Mode of action of lead like arsenic after intake is both local as well as remote:

- **Local effects** are irritation mainly on gastrointestinal tract and lungs. Gastrointestinal symptoms are acute abdominal cramps, vomiting

and diarrhea. Industrial workers refer to this syndrome as "plumies". Diarrhea may be replaced by constipation and stool may contain black lead sulfide. Morphological discoloration due to deposit of lead at the gingival margin appears as *lead line*. Respiratory symptoms are acute discomfort in the throat and pharyngeal burning.

- **Remote effects** of lead after absorption are mainly on the *blood cells* and *nervous system*.
 - Effects on the blood cells** are chiefly due to its coating of blood cells, which gets damaged and membrane of red blood cells break causing their hemolysis with subsequent development of anemia. Stippling of blood cells is coarse, basophilic and granular. Staining of blood cells by methylene blue demonstrates it. Exact significance of this stippling is not clear. It is not confined to lead poisoning alone and is not diagnostic.
 - Nervous system effects** of lead are both on *brain* and *peripheral nervous system*.
 - In brain, lead causes widespread degeneration of the cortical and ganglionic neurons with diffuse edema of grey and white matter.
 - Peripheral lesion affects chiefly the motor nerves of most active muscles producing degenerative changes in the axis cylinder. The nerves of the extensor muscles of wrists and fingers followed by leg muscles are affected. Palsies of ulnar or plantar type occur e.g. finger, wrist and foot drop.

Acute poisoning occurs following ingestion of lead with suicidal intent or takes place through lungs in industry from inhalation of vapors.

Chronic poisoning also known as plumbism, is more prevalent and occurs due to cumulative action of lead in industry. Symptoms mainly are gastrointestinal (already described), neuromuscular symptoms and encephalopathy. Neuromuscular symptoms are muscle weakness leading to actual paralysis such as wrist drop. Involvement of the motor system and absence of sensory disturbances is an important differentiating point from other peripheral neuropathies. Atrophy may occur from continued disuse. Encephalopathy is found in children. The illness is sudden with presenting symptoms of coma, convulsions, mania or delirium. Anemic form shows up as pallor of the skin, general weakness and ill health. Insomnia, headache and dizziness are common symptoms.

Storage of lead in the body is chiefly in lamellar and cortical portions of bones. Deposition of lead in bones is permanent effectively removing it from circulation. It is excreted in urine through kidneys at a very slow rate. Some of it is also eliminated in stools.

Association of lead poisoning with other diseases such as sclerosis of the kidney and hypertension though has been claimed, yet proof of this association is usually lacking. These diseases exist naturally as well. Mere circumstances suggest this connection. A specific renal change does occur during plumbism, which leads to chronic renal sclerosis with hypertension.

Autopsy findings are non-specific. There are irritation signs in the gastrointestinal tract, black stool, lead lines on glottis and renal changes. Brain may be congested showing edema and increase in weight. A long bone should be preserved for analysis beside blood, urine, liver, kidney and brain.

Mercury is easily obtained and used in many industries. Metal itself is non-poisonous, but poisoning results from soluble mercury salts, and by volatilization of the liquid metal. There are two types of salts:

- *Mercuric salts* are more soluble and poisonous
- *Mercurous salts* are less so

Absorption of salts of mercury is from skin, gastrointestinal tract, and lungs. Mercury vaporizes at room temperature gets into the body through respiratory tract. Absorption both from skin and lungs occurs in workers at Finger Printing Burrow in criminal investigation from use of mercurial dusting powder.

Fatal dose is 3-5 grains.

Mode of action of mercury compounds is that they interfere with the sulphhydryl enzymes like other heavy metals. Mercuric chloride is the commonest mercurial poison. Its tablet when used as germicidal or for contraceptive purposes ensures almost certain death. Mercurial diuretics also cause poisoning and anaphylactic reaction. The mode of death in such cases is ventricular fibrillation.

Acute poisoning is uncommon and signs and symptoms are similar to arsenic poisoning. Taste is more metallic and purging is more violent and grave. Salivation develops on the second and third day. Gums become swollen, inflamed and the breath foul. Renal lesion soon becomes established with the

development of oliguria with albuminuria. Thirst, dehydration, collapse, twitching or minor convulsions may precede death.

Chronic poisoning occurs in industry and symptoms may be lassitude, dizziness and palsies. Nephritis may occur from elimination of the mercury through the kidney causing intense catarrhal necrosis of tubular epithelium. Handling of mercury, over long periods, causes fulminating skin itch. Most alarming symptoms are shakes and tremors with emotional instability. Other symptoms include loss of appetite, occasional vomiting, diarrhea and progressive anemia.

Most of the symptoms of chronic poisoning occur with inorganic compounds. Organic compounds cause severe generalized ataxia and gross constriction of visual field. Memory and intelligence remain unaffected.

Autopsy findings of poisoning by mercury salts especially corrosive and irritant effects are apparent on throat, gullet and stomach and even intestine. The mucous membrane of intestine becomes white and wrinkled and the underlying tissue gets edematous and inflamed. Kidneys manifest signs of irritation showing tubular swelling and necrosis. The colon may ulcerate and even sloughs.

There may be necrosis of liver, extent depending upon whether poisoning was acute or chronic or patient died of anaphylactic shock.

Corrosive lesion to the skin and internal lining surfaces of the body organs occurs, when a strong acid or alkali come in contact. Strong corrosive substance has the property of destroying the texture of the tissue it meets. Some corrosive substances have additional systemic effects after their absorption.

Strong mineral acids are sulfuric acid, nitric acid and hydrochloric acid. **Weak organic acids** are carbolic acid (phenol), oxalic acid and acetyl salicylic acid. Important **strong alkalis** are sodium hydroxide (caustic soda), potassium hydroxide (caustic potash), sodium carbonate (washing soda) and ammonia.

Signs and symptoms are principally because of local effects. Vulnerable sites externally are exposed areas of the body such as skin of face, hands and feet and internally mucous membranes of stomach, intestines and respiratory passages. Local lesion has varied appearance ranging from simple erythema, going through different degrees of destruction to

massive corrosion of the tissues, which finally may acquire the shape of an ulcer having acute inflammatory reaction. The lesion also shows staining on the skin and the clothes related to the type of corrosive. Litmus reaction at the periphery of the lesion will be in accordance with type of corrosive used.

If ingested while in sitting position, external effects are on lips, lateral aspects of chin due to irritant and dribbling effect and then on groins by dribbled solution when it falls down on thighs. Internal effects are on cavity of mouth, throat, and upper alimentary tract. Pain is intense in stomach and upper intestine. It may cause difficulty in swallowing. If corrosive substance has fuming property, it may additionally affect nose, eyes externally and may gain entry into respiratory passages by inhalation, affecting nasal mucosa and lungs. Effect on respiration is choking. Vomiting may occur, which has the smell of the ingested corrosive, blood stained or of dark brown color due to the presence of altered blood. The vomit will also show effervescence on contact with earth in case of acid. Affects vary with amount taken, duration of contact and concentration of the solution.

Lips, angles of mouth, skin of lower part of face and mucosa of mouth, esophagus or stomach all get corroded, eventually produces perforation of stomach and first part of duodenum and peritoneal damage. When inhaled, lung tissue is badly damaged. If the patient survives, the residual effects of such corrosions are esophageal, laryngeal and pyloric stenoses and fibrosis of the lungs. (Photo.16.5 & 16.6 A, B & C of same victim)



Photo.16.5: Weak mineral acid (non-fuming) ingestion showing staining (external) on lips and lateral aspects of chin spearing involvement of nose



Photo.16.6: Strong mineral acid (fuming) ingestion A, showing external corrosion of lips, angles of mouth, chin and nasal opening



Photo.16.6: B. Corrosion marks on groins due to dribbled of acid

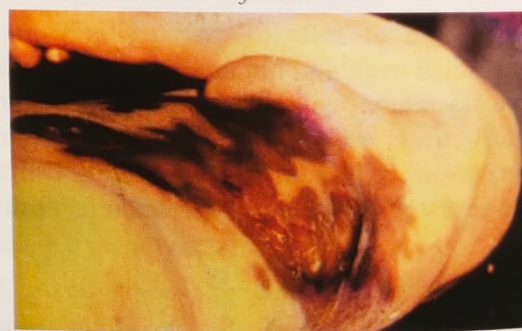


Photo.16.6: C. Leaked ingested acid through perforation of stomach/intestine into peritoneal cavity and up to skin of left chest/abdomen causing corrosion

Sulfuric acid is one of the strongest nonvolatile mineral acids used mainly as a reagent in laboratory. It is also used in car batteries. 30% concentration is strong enough to harm the mucous membranes. Locally it produces the sensation of heat followed by pain. It blackens the tissue before actual destruction. The change of color is from gray to black. It is also known as oil of vitriol and is thrown to cause disfiguration of face usually in cases of morbid jealousy.

Hydrochloric acid has similar but milder actions to that of sulfuric acid. Effects vary from irritation to minimal corrosion. Being a fuming acid, it additionally affects the respiratory tract. Skin is not stained but mucous membrane shows stains like those with sulfuric acid.

Nitric acid behaves similar to sulfuric acid and being more volatile has stronger effects on the respiratory tract. Skin stains are yellow in color, which later turns brown.

Strong alkalis mainly sodium or potassium hydroxide have similar effects as those of the mineral acids, more so on the mucous membranes. Vomiting is copious showing frothy reaction with gastric hydrochloric acid. The vomit is first of white color and later becomes black. Local irritation causes excess secretion of mucous, which in turn increases motility of the gastrointestinal tract and cause purging. Ammonia emits fumes, which intensely irritate eyes and respiratory tract.

Oxalic acid has both local and systemic action. Locally it acts as weak corrosive having much milder effects than the mineral acids. It tastes acidic in mouth and causes burning sensation in the stomach. Systemic effects after absorption are depression of nervous system finally causing unconsciousness and death of vital centers. The pulse becomes weak, irregular and eventually imperceptible. Skin is cold and clammy. In whatever concentration the poison is taken, the person rapidly becomes prostrated. If in an erect posture, he falls down. Respiration becomes labored with long intervals between inspirations. If death is delayed, diarrhea occurs. Christison's saying spells out effects of oxalic acid:

"If a person after swallowing a solution of a crystalline salt, which tasted strongly acidic, immediately suffers from burning sensation in the throat and the stomach and also vomits, especially of bloody matters. Further, his pulse becomes imperceptible and he dies in ten, twenty or thirty minutes, I do not know any fallacy, which can interfere with the conclusion that oxalic acid was the cause of death. No disease begins so abruptly nor ends so soon and no other crystalline poison has the same effects."

Carbolic acid (phenol) is a good disinfectant. Although it is an acid, yet it shows no reaction with litmus paper. It has colorless crystals, which becomes pink on exposure to light and air. It has an intense penetrating, characteristic odor. It acts locally and has

systemic effects as well. It is easily absorbed from the skin and mucous membrane. Local application causes burning sensation followed by numbness. Skin surface shows burns but pain is not proportionate to the extent of burn because of its anesthetic properties. Being a protoplasmic poison, the systemic effects are mainly on central nervous system. It depresses both higher and medullary centers especially cardiac and respiratory. It is excreted in urine and breath, which smells of carbolic acid. Urine darkens on exposure.

It is the most common suicidal poison. Accident comes next and homicide with phenol is rather impossible because of its intense taste and characteristic smell. The autopsy findings are staining of lips, skin or face, congestion and corrosion inside of mouth and stomach. There may be perforation of stomach, leading to the leakage of the corrosive into the peritoneal cavity resulting in peritonitis. Trachea, respiratory passages and lung tissue show congestion, edema and chemical pneumonia may occur.

Medico-legal implication of mineral acids and alkalis is that they are mainly used as laboratory and industry chemicals and are thus accidental materials. Organic acids have the ability to remove stains from clothes and are therefore, responsible for domestic accidents. Homicide is not possible; however, strong acid has been used to destroy the dead body of the victim to eliminate evidence of crime. Suicide by ingestion of strong corrosive agents used to be common but now there is decline in this method, because of availability of other quick and painless methods.

Important alcohols are methyl and ethyl alcohol.

Methyl alcohol is used mainly in industry. It is cheap as well as freely available. Another use of methyl alcohol is as a denaturing agent for ethyl alcohol. Though it is not intended for ingestion, yet many people misuse it in spite of its toxicity.

It is quickly absorbed both from stomach and intestine, but slowly metabolized in the body. 80% is eliminated out of the body through lungs. Its metabolic products are formic acid and formaldehyde, which can be identified in urine, as 3% is excreted in urine.

Symptoms after its ingestion vary according to the amount taken. Pupils get dilated and marked depression of respiration occur causing cyanosis and acidemia. Prolonged use is associated with optic nerve atrophy, which produces some residual

blindness. The blindness may clear up temporarily only to become permanent a little later. Death is usually from respiratory depression. Most deaths are due to alcoholic coma or inhalation of stomach contents. Postmortem findings are non-specific except for visceral congestion, smell of alcohol and cyanosis. Blood and urine are collected during autopsy and contains formic acid and formaldehyde.

Ethyl alcohol is present in all hard drinks in different concentrations, which contain small quantities of ether, ketones and essential oils. These substances are responsible for color and odor of various drinks.

Absorption of Ethyl alcohol, unlike other foods, does not require digestion in stomach because of its small molecular size. Ninety percent is rapidly absorbed both from stomach and small intestine in the first hour. Peak level in blood is reached in one hour depending upon the condition of stomach, type of food and type of hard drinks, its concentrations and ability of body to tolerate alcohol.

A small stomach and one after partial gastrectomy empties quickly and alcohol passes into small intestine for ready absorption. The person becomes intoxicated very rapidly. Fatty food and substances cause pylorospasm and atonia of the stomach, which delay emptying of stomach and in turn absorption from intestines. Type of stress also influences emptying of stomach thus affects the absorption. Higher the concentration of alcohol, rapid shall be absorption and higher will be blood level. Very high concentration of alcohol causes pylorospasm, delays its reach to small intestine and absorption.

After absorption from the gut, it goes to the portal circulation, through the inferior vena cava to heart, then to pulmonary circulation and finally to the whole body. Body tissues take up alcohol according to their water contents. Fat and bones being relatively water free retain only little alcohol.

Mode of action of ethyl alcohol is physiological depression of central nervous system passing through four stages:

- In the first stage, it causes apparent stimulant action responsible for initial excitement.
- In the second stage, depression of the highest centers frees lower centers from cortical control removing inhibition and quality of appreciation.
- In the third stage, alcohol decreases awareness and also reaction to sensory stimuli, affecting mainly

sensorium of touch and vision. Stronger stimuli are required to elicit pain as its threshold is raised. Ability to distinguish colors is affected and person generally requires stronger illumination.

- In the final stage, it effects coordination of sensory and motor activity affecting especially ocular muscles (both extrinsic and intrinsic) and thus produces abnormal eye movements, dilatation of pupil and uncoordinated behavior.

Signs and symptoms vary, and have a relation with the amount taken and how often taken. Regular intake of alcohol produces tolerance, reducing its effect to a given dose. Alcoholics show little or no effect to a dose, which is quite sufficient for a non-alcoholic to have him intoxicated. Effects can be placed in four groups in accordance with the above four stages:

- First is the stage of excitement and a sense of well being called euphoria. An individual tends to lose emotional restraint and begins to talk with abundance, but he can remain sober with force of will power.
- Second is the stage of confusion beginning with loss of coordination. A person comes to grief and emotional upset, which may be marked. He becomes confused over any problem. Speech may become slurred and he loses control of finer movements.
- Third is the stage of stupor in which a person is dead drunk, but can be roused only by strongest stimuli. *This stage resembles cerebral disease and head injury.*
- Final stage of acute intoxication is last stage of paralysis of respiratory center, leading to respiratory failure and anoxia especially of brain. Blood alcohol level in this stage is over 400-mg/100ml. There may be vomiting and inhalation of vomit prior to death.

Fate of alcohol in the body is that ninety percent is oxidized and rest is excreted through lungs in breath, kidneys in urine and very small amount in saliva and sweat. About 10 cc. is oxidized per hour. Oxidation of alcohol into acetaldehyde by enzyme dehydrogenase mainly occurs in liver as first stage of oxidation. Next stage of oxidation takes place in muscular tissue. Acetaldehyde is a toxic substance. Because the next stage of oxidation takes place quickly, it does not cause toxic symptoms.

Owing to the ease with which alcohol is oxidized, it replaces other substances in energy

production; it diminishes the breakdown of fats and carbohydrates without affecting the breakdown of protein. Consequently, a serious metabolic disturbance occurs and hypoglycemia may follow in very heavy drinkers on stoppage of alcohol.

Relationship of alcohol to traffic accident is intimate. *Road Traffic Act 1958* prohibits driving a vehicle while under the influence of alcohol. The ability to drive depends upon proper skill of driving and medical fitness of driver. Medical fitness depends upon normal reaction time of an individual. Reaction time means the time from the moment one sees a cause for action, through the mental process of deciding what action to take to the first operative movement to give effect to that decision.

Under normal condition of physical health, an experienced driver may get his reaction time down to 0.3 second. Travelling at 30 miles per hour, a car would have covered 13.2 feet before any action to alter its direction or velocity has occurred. When the reaction time is 0.5 second, the distance covered by the car at a speed of 30 miles per hour will be 22 feet.

Alcohol, being a central nervous system depressant, prolongs reaction time and causes slowing and lack of muscular coordination decreasing skill of the operator. The relationship of alcohol to road traffic is bound up with the basic premise that he who cannot control him cannot control a motor vehicle.

Medical examination of the driver in cases of traffic accident is necessary, being a requirement of law to determine absence of any impairment of driving ability due to disease, alcohol or any other drug. The police have a duty to arrange this medical examination, which is only possible by proper and full clinical examination. It is also the only means of detecting any physical illness, head injury or any other factor responsible for the behavior of the suspect. This medical examination has its specific requirements and being a legal responsibility, only trained and experienced Medical Practitioner should undertake it. Further, clinical opinion must be supported with results of chemical analysis of collected specimens during medical examination. It is emphasized that there is no scientific basis for the use of clinical examination in the absence of chemical tests.

Steps of such a medical examination after an accident by the driver are starting with consent

procedures, history, physical examination and collection of samples:

- Consent for medical examination must be obtained from the examinee (driver) before the start of examination. In order that his consent is valid, the purpose of examination must be explained. In unconscious suspect, an immediate examination should be made to decide whether any urgent medical treatment is necessary. But no information obtained in the course of this examination other than the fitness or otherwise of the suspect may be given to the police until the suspect has recovered sufficiently to give his valid consent to its disclosure.
- History includes type of last food, any medication with time and quantity of last dose, fits or any other disease. Last question during history taking should be about hard drink, its amount and time of intake.
- Physical examination should be segmented into general, systemic and local examination. Important observations during these stages of examination are about state of dress, presence of any vomit or soiling of clothes by incontinence of urine, speech whether thick or slurred, extent of self control, notes about temperature, pulse, blood pressure, respiration, color of skin and degree of perspiration. Attention should be paid to the condition of tongue, teeth whether artificial and glasses (artificial eye- contact lenses, color etc.). Responses of intrinsic and extrinsic muscles of eyes (pupils whether equal and their reaction to light and convergence, strabismus or nystagmus) should also be noted. Examination of ears should be done to detect any impairment of hearing, presence of discharge or abnormality of drum. Noting manner of standing, walking, turning and testing balance with both eyes closed can assess lack of muscular coordination. Placing a finger on the nose, picking up some object, buttoning and unbuttoning of clothes are common tests in this connection.
- Collection of samples is an essential duty in such cases. Important specimens in living cases are stomach wash, blood and urine and all of them should be collected. While collecting blood precautions to avoid contamination and evaporation must be taken.

In other countries, special kits have been provided for the collection of the blood samples. The kit consists of three plastic cups with lids and three labels with wires to attach one to each cup, sterile

disposable syringe and sterile dressing. Hands should be washed with soap and water and dried with clean cotton wool in the presence of accused. Region selected for collection of blood sample is also washed with plain water and soap. Vein puncture using disposable sterile syringe and needle is becoming the method of choice. Collected sample is divided into three parts, first and third for the prosecution and second for the suspect.

Breath is the other specimen that contains alcohol excreted by lungs. It is now becoming an attractive medium for estimating the tissue alcohol concentration. Basis for breath analysis is that there is a constant partition factor between the alcohol concentration in pulmonary circulation and in the alveolar air. Conversion factor is based on the theory that 2100 ml of alveolar air contains the same amount of alcohol as in 0.1 ml of blood.

Breath analyser has been in use since long and has proved reliable. It measures the amount of alcohol in a sample of 25.5 ml of alveolar air. Its successful use has been reported from Australia, Switzerland and France. Breath analysis has been carried with index tubes as a useful roadside-screening test. Now it is claimed that a special index tube can provide an accurate quantitative result and the tube can be preserved as evidence for presenting to the courts as the change of color is permanent.

From the corpse, blood is taken from a vein and as soon as possible after death. Products of decomposition will interfere with blood alcohol concentration. Special attention should be paid to the oxidizing poisons like methanol and ketone. Nature of treatment given before death must also be ascertained. Pleural and gastric samples taken 24 hours after clinical death showed 20-30 mg/100 ml of alcohol in them. Because of methanol contamination in mortuaries, it has been suggested that a quantitative test for methanol should also be done. All results yielding 20 mg per 100 ml should be treated as negative.

Medical certificate should contain, besides medical findings related to alcoholic intoxication observed during physical examination, notes excluding head injury or other pathological states simulating alcohol intoxication. Notes about date, time of beginning and ending of the examination and some reference to the light of the room and place of examination should also be included. (Table 16.2)

Table 16.2:

Pathological states simulating alcohol intoxication

1. Head injuries (cerebro-vascular emergencies)
2. Metabolic disorders (hypoglycemia, diabetic pre-coma, uremia, impaired liver function and hyperthyroidism)
3. Neurological conditions (associated with dysarthria, ataxia, tremors, drowsiness), disseminated sclerosis, intra-cranial tumor, Parkinson's disease, epilepsy, acute aural vertigo
4. Drug intoxication (insulin, barbiturates, antihistamines, morphine, large doses of the tranquilizer) and carbon monoxide poisoning.
5. Psychiatric pre-existing conditions (hypomania, general paresis)
6. Other miscellaneous condition (high fever, certain confusional states, amnesia, aphasia or vertigo)
7. Conditions in which small quantity of alcohol seriously impairs coordination:
 - i. Exposure to extreme cold and fatigue.
 - ii. Pre-existing confusional states.
 - iii. Partial gastrectomy
 - iv. Cerebral states (hypertension, cerebral artero-sclerosis and depression.
 - v. Neurological and psychiatric conditions.

Laboratory analysis of alcohol in blood is an important examination and can be done by many methods:

- **Widmark**
- **Enzymatic**
- **Chromatography**

Widmark method is based on the principle that ethyl alcohol reduces dichromate and changes its color from yellow to green. The change of color can subsequently be estimated by colorimeter. This reaction is non-specific, time consuming and uneconomical in terms of laboratory staff. Both macro and micro methods are available.

Enzymatic method is though more specific for ethyl alcohol yet not recommended if the laboratory responsible for the testing does not receive many samples and is a method of choice of postmortem material. Reaction is based on the conversion of D.P.N. to D.P.N.H, by enzyme A.D.H. It is better suited to a laboratory handling large amount of samples.

Chromatography is completely specific for ethyl alcohol, very sensitive and method of choice for future. Presently the test is not available to all.

Barbiturates, when listed as medicines, added new problems to the medical profession. Long acting barbiturates like phenobarbitone have replaced

bromide intoxication, Over-prescription by medical doctors and lack of control on their availability has increased its abuse. Drug Regulations restrain is insufficient and has been futile. Medical professional should realize its responsibility.

They can be grouped into three sub groups:

- Long acting --- barbitone and phenobarbitone
- Intermediate acting --- amylo-barbitone buta-barbitone
- Short/ultra- short acting --- thiopentone sodium is used mainly as an intravenous anaesthetic. It is distributed throughout the body within minutes of administration. It is metabolized in the liver rapidly and completely. Its amount in the blood will depend upon rapidity of death, if survival prolongs, blood sample will be negative.

Absorption, metabolism and distribution of intermediate and long acting barbiturates depend upon the type of barbiturate. More lipophilic the derivative, the faster will be absorption from small intestine, more rapid will be the distribution in the tissue and the more extensive will be the bio-transformation. The long acting compounds are absorbed more slowly and significant proportion will be excreted unchanged and their metabolites are mainly excreted in the urine. Ninety percent is excreted out of the body in over 48 hours. In case of phenobarbitone, thirty percent is excreted unchanged.

Fatal dose varies with type of barbiturate. For long acting, the dose is 30-50 gm, for intermediate acting 20-30 gm and for short and ultra-short acting 12-20 gm. Fatal blood level also depends upon the type. For fast acting blood level is 2-3 mg. /100 ml and for slower acting 4-8 mg. /100 ml is achieved without any measurable amounts being excreted in urine. Rapidity of death depends upon the rate of onset of effect. With short acting, many people die rapidly due to fall of blood pressure or cardiac output. More usually, it is due to paralysis of the respiration, poor oxygenation and shock. With intermediate acting, mortality is low provided the patient reaches a hospital.

Detoxification reaction undergone in the body by many involves oxidation of the larger substitute on carbon atom '5'. Oxidation results in the formation of alcohol, ketones, and caboxylic acid, which is then excreted into the urine.

Mode of action of barbiturates is that they produce respiratory paralysis and any delay in the initiation of treatment would inevitably result in

irreversible cerebral anoxia. Cerebral anoxia once fully established, extensive treatment and even complete elimination of the drug from the circulation will not cure coma, which persists due to the death of the cerebral tissue. Medical treatment, therefore, should be given as quickly as possible, and should be directed to the prevention of anoxia. Simultaneously, adequate urinary excretion should be maintained to eliminate the drug. Sodium salts are extremely alkaline and severely irritant to gastric mucosa and renal tissue in large quantities.

Signs and symptoms of poisoning are mainly due to respiratory depression and fall of blood pressure precipitated due to anoxia. They act both on special centers causing amnesia and lower cerebral centers producing drowsiness. There are three stages:

- *First stage* is of excitement, talkativeness, hallucination, confusion and lack of coordination.
- *Second stage* is of unconsciousness, which deepens with time. During this stage pupils are usually small, fixed and respiration slow and strenuous. Reflexes are greatly diminished or even lost.
- *Third and final stage* is of deep coma in which there is no response to superficial stimuli. Pulse rate may be normal but the blood pressure continues to fall.

During recovery, the process is reversed. Patient again becomes excited, show lack of coordination and slurring of speech before full recovery. Death in these cases may be due to direct effects on vital centers causing respiratory failure and ventricular fibrillation. An individual suffering from chronic respiratory disease, cardiac disability and advanced coronary disease may die more quickly. When death is due to complications, the patient has irreversible cerebral anoxia, bronchopneumonia and pulmonary edema.

There is always a moderate degree of hypothermia and the best way to correct it is to warm the inspired air. Skin lesions due to coma occur in the form of patchy erythema, which later becomes a vesicle or a blister usually on areas of pressure. They may be incorrectly attributed to burns.

Diagnosis of poisoning is based on clinical state and results of analysis. A good screening test is that all barbiturates except thio-group give a violet color with copper isopropylamine. Ultra-violet spectroscopy is based on absorption spectrum and it shifts with pH. Both protein free blood and tissue fluid extract can be tested. Chromatography is very

sensitive and specific. Stomach may contain a capsule or staining caused by the capsule color or mild corrosion of mucosa at the site of capsule.

Postmortem appearance depends upon the rapidity of death. Non-specific anoxic picture is usually seen. It softens globus pallidus, also seen in CO poisoning. Multiple punctate hemorrhages in white matter of brain and general congestion with blue color of the skin appear. Lungs may show congestion, edema and petechial hemorrhages. Right side of heart is dilated, filled with blood and shows hemorrhages on the surface.

Poisonous plants grow wild and are now grown for ornamental purposes. Medicinal chemicals were initially used to be isolated from these plants and toxic constituents having no therapeutic value also got extracted with these medicinal chemicals. Criminals may use these plants to cause abortion, stupefy other persons and even to cause homicide. These poisonous plants are of immense forensic importance. Important poisonous plants are *poppy*, *atropa* group, *tobacco*, *coca*, *Indian hemp* and *nuxvomica*.

Poppy plant (*papaver somniferum*) is abundantly cultivated in Northern region of our country and opium is its dried juice. Opium contains alkaloids namely *morphine* (10%), *narcotine* (6%), *papa venue* (1%), *codeine* and *dionin* (traces). Synthetic substitutes have been prepared and important among them are *pethidine* and *methadone*. Re-synthesis from alkaloids of opium has lead to the formation of *heroin* (*diacetylmorphine*) which is structurally similar to *nalorphine*, a morphine antagonist. Alkaloids of opium and other similar synthetic substitutes prepared from them are called *narcotics*. All of these drugs are habit forming. (Photo.16.7)



Photo.16.7: Extraction of opium from poppy fruit A. Natural plant B & C. Magnified fruit D. Oozing of juice E, F & G. Drying of fruit

Mode of action of both natural and synthetic drugs is almost similar. These drugs cause narcosis by depressing the central nervous system. They produce stupor, which eventually deepens into cyanotic coma, and death occurs due to respiratory depression or super-added chest infection.

Acute poisoning is produced by alkaloids of opium are similar to each other. Important signs and symptoms are classical pinpoint constriction of pupils, slow pulse and respiration and sub-normal body temperature.

Use of nalorphine 5-10mg. improves respiration. Oxygen should be administered and stomach must be washed with dilute potassium permanganate solution, which will oxidize the alkaloid. If morphine has been taken parentally, the drug is excreted back into the stomach and intestine with bile.

Chronic poisoning (addiction) leads to ill health, emaciation and anemia.

Autopsy findings are anoxic type such as acute cyanosis, congestion of internal organs, pinpoint pupils which go widely dilated as a terminal event and injection marks at forearm, ankles and buttocks which may also show infection.

Specimens, which should be collected during autopsy are stomach and small intestine with their contents, liver, spleen and kidney besides blood, urine and bile.

Medico-legal importance is that these drugs are drugs of addiction and taken for suicidal purposes. Opium had been the most common choice, but now heroin has replaced it. Opium is not a good suicidal poison as it requires more than 200 mg. and there is delay in onset of action. Homicide is not possible because of its bitter taste. Addicts who are informers may be killed with either extra rich drug or by addition of strychnine as punishment. Accidental poisoning because of its addictive action or overdose toxicity is a distinct possibility.

Atropa group comprises of *datura fastuosa* and *stramonium*, *atropa belladonna* and *hyoscyamus niger*. *Datura stramonium* is further of two types, *alba* and *niger*. All parts of these plants like fruit, leaves, stem and seeds are poisonous. Active principles in them are their alkaloids namely *hyoscyamine* (mainly) and *hyoscyne* (small amounts). *Atropine* is obtained from *hyoscyamine*.

Datura stramonium seeds are black kidneys shaped having rough surface with pitted depressions. Size of this seed is 3-4 mm. Weight of one hundred

seeds is about 1 gram. On section, embryo is seen along the margin of the seed.

Hyoscyamus seeds are light brown and kidney shaped, size is of a pinhead. Surface has pitted depressions. Section shows embryo, which is not as near to the margin as of *datura stramonium*.

Belladonna seeds are blackish purple having all other characters similar to *hyoscyamus*.

Atropa group poisoning takes place either by ingestion of various parts of these plants or administration of their active principles.

Absorption, distribution and metabolism of all the alkaloids are similar. After ingestion of crushed seed, absorption of alkaloids takes place from first part of small intestine. From there through blood circulation, it goes to body tissues where alkaloids undergo partial oxidation. When seeds alone are eaten, effects appear within half an hour and when alkaloids are administered, symptoms appear almost at once. Analyst, due to their oxidation in the tissues, may not detect them. A part of the alkaloids is excreted in urine. (Photo.16.8)

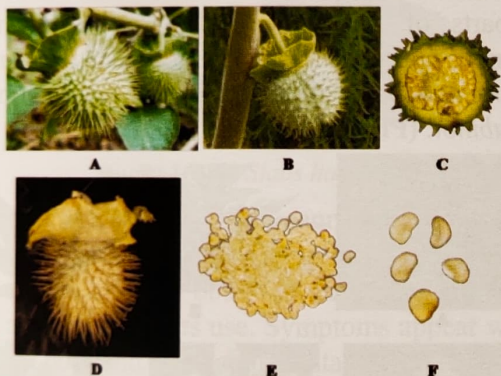


Photo.16.8: Component of the *datura* A. Natural plant B. Fresh fruit C. mid section D. Dried fruit E. Extracted seeds F Magnified seeds

Mode of actions of all the alkaloids of this group namely atropine, hyoscyamine and hyoscyne are the same. Alkaloids act both on central nervous system and peripheral:

- **Central nervous system** these alkaloids first stimulate higher centers of the brain, then the motor centers and lastly cause depression and paralysis of the vital centers in the medulla and inhibitory fibers of the vagus
- **Peripheral effects** are due to cholinergic blockage with resultant paralysis of the parasympathetic nervous system

Signs and symptoms of atropa group poisoning are mainly diminishing of the body secretions,

dilatation of pupils and superficial blood vessels especially of the face and rise in body temperature. *Statement that hot as a hare, red as a beet, dry as a bone, blind as a bat and mad as a wet hen aptly reflects the clinically state of the patient.*

Patient becomes restless and talkative having incoherent speech is confused, giddy and staggers as if drunk. Body muscles show lack of coordinated movement with muscular tremors. He may suffer from fits of laughter with delusions and may perform purposeless movements, such as touching imaginary objects, threading needles and picking objects. Finally, he may go into deep sleep passing into irreversible coma, which may end his life from respiratory paralysis.

During the early stage of recovery from deep sleep, he again becomes restless and noisy. Excitement may become destructive. Differential diagnosis is from alcoholic delirium and acute schizophrenia.

Autopsy findings are non-specific. There may be congestion along with other signs of asphyxia. Pupils remain dilated even after death. A dry warm body having widely dilated pupils may be the only clue. Contents of the stomach and intestine must be searched for seeds.

Medico-legal implications are that children are more susceptible and accidental poisoning commonly occurs in them who may eat fruits of the plant. Criminal administration of these drugs is for the purposes of robbery. It is on record that medicinal use has also caused poisoning.

Tobacco leaf extract contains nicotine and is smoked in various forms like cigar and cigarettes and by various other means like *pipe* or *huqqa*. It is a potent contact poison, occasionally also used as an insecticide. Accidental poisoning occurs in children. (Photo.16.9)



Photo.16.9: Tobacco preparations A. Natural plant B. Fresh leaf's C. Single dried leaf D. Bunch of dried leaf E. Prepared tobacco F. Nicotine powder

Absorption of nicotine through gastrointestinal tract is slower than skin. Quickest absorption is through inhalation of its vapors. After entry into blood circulation, it is distributed to all body tissues.

Mode of action is that it stimulates autonomic ganglia both sympathetic and parasympathetic, neuromuscular junctions and certain neuronal pathways of central nervous system.

Signs and symptoms resemble those of acetylcholine overdose. Initially it causes dizziness, miosis and vomiting. Weakness, muscular tremors and convulsions follow it. Depression of central nervous system occurs later and death is due to respiratory failure both from paralysis and blockade of central respiratory mechanism. Clinical picture is quite complex and may be different in two cases. It may cause palpitation and tachycardia by a stimulation of sympathetic ganglia or blockade of parasympathetic ganglia in one and in another case, it may produce bradycardia by blocking of sympathetic ganglia or stimulation of parasympathetic ganglia.

Coca plant is tropical in origin and its leaves contain an alkaloid known as cocaine. It was previously used a local anaesthetic. Addicts use it either as a nasal snuff or inject it intravenously to elevate mood and to attain a state of hallucination. (Photo.16.10)

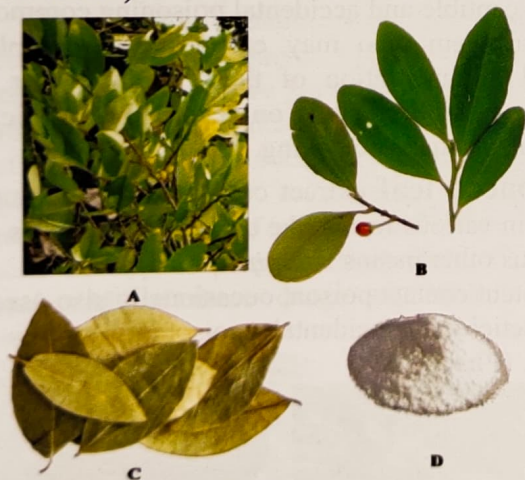


Photo.16.10: Cocaine preparation A. Natural plant B. Fresh leaf's C. Dried leaf's D. Cocaine powder

Mode of action is that surface application produces sensory loss for about 30 minutes to an hour. In addition, it causes vasoconstriction of local blood vessels. Both effects are reversible. Some people are allergic to the drug. It is no more used as a local anaesthetic because of its local toxic effects.

After absorption from mucous membranes, it first stimulates cerebral cortex and then depresses it with production of hallucination. About fifty percent is excreted unchanged in urine.

Signs and symptoms of intoxication are excitement, euphoria and dysphagia. It occasionally causes nausea, vomiting and abdominal pain. Hypotension, respiratory paralysis, coma and convulsions follow these symptoms. When taken intravenously, it immediately produces euphoria, tremendous self-confidence and feeling of superiority. Toxic psychosis has paranoid element. Snuff may produce perforation of the nasal septum.

Autopsy findings are consistent with anoxic picture. It also produces local ischaemia of stomach mucosa and perforation of nasal septum. Sunlight decomposes it and for this reason, it is not easily detected in the necropsy material. Body tissues are collected in dark brown bottles and the specimens are stomach and small intestine with contents, liver, spleen and kidney besides blood and urine.

Indian hemp is also called *Cannabis Indica*. All parts of the plant, leaves, flowers, stem are poisonous and yield a sticky, amorphous resin known as *cannabinone*, which contains its active principle *cannabinol*. (Photo.16.11)

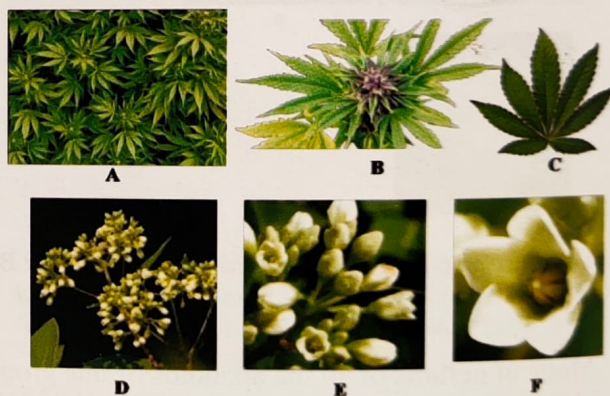


Photo.16.11: Parts of plant of *cannabis indica* A. Natural plant B. Bunch of leaf's C. Magnified leaf's D. Bunch of flowers E. Magnified bunch of flowers F. Magnified single flower

It is commonly used in the form of *Bang*, *Majun*, *Ganja*, *Chars* and *Marihuana*:

- *Bang* consists of dried leaves and fruit shoots and is used to prepare a beverage, which contains its active principle in 15 % concentration. It is the least potent of all other forms and its use produces cheerfulness. The effect lasts for about three hours followed by sleep.

- *Majun* is a sort of sweet made from bang mixed with flour, milk, butter and sugar. The preparation is solid and may be made into lozenges, 1-3 of which is the usual dose to seek pleasure. The most important effect that it produces is delusions.
- *Ganja* consists of the flowering tops of the female plants. Preparation is rusty green in color and has characteristic odor. It contains the active principle in 25 % concentration. It is mixed with tobacco and smoked in a special pipe. The effects produced are pleasure and laziness though the intoxicated is able to perform duties.
- *Chars* also known, as *hashish* is a resinous exudate prepared from the leaves and stems of the plant. It is dark green or brown in color. It contains its active principle in 25-40% concentration. It is smoked with tobacco in special pipes and is the most potent of all other forms.
- *Marihuana* or *marijuana* is Mexican terms for chars, meaning 'pleasurable feeling'. When rolled into a cigarette, it is called *Reefers*. (Photo.16.12)



Photo.16.12: Slabs hashish

Signs and symptoms of cannabis poisoning are of two types, acute and chronic poisoning:

- **Acute poisoning** is observed in persons, who are not accustomed to its use. Symptoms appear within half an hour and there are two stages:
 - a) First stage is phase of *inebriation* followed by narcosis. Initially patient is excited, euphoric, heavily pleased with him. He becomes talkative and experiences hallucinations, uncontrollable laughter and purposeless muscular movements. There is increased appetite and the patient enjoys his food.
 - b) Second stage is phase of *intoxication* with loss of orientation of both time and space. He becomes drowsy and delirious. He may occasionally become paranoid with homicidal tendencies. There is muscular weakness, dilatation of pupils, tingling and numbness of extremities and generalized anesthesia. The patient finally passes into deep sleep.
- **Chronic poisoning** results from continued use of the drug. It is characterized by anorexia, loss of

weight, weakness, tremors, impotence and moral degradation. Some patients additionally suffer from hallucinations and delusions about sex and property and develop a tendency to commit crimes. There is an irresistible impulse to destroy life and property, which may lead to "run amok". It is a state produced by continued use of cannabis and is characterized by indiscriminate murdering.

There is disagreement regarding potential of cannabis as a drug of addiction. There are no withdrawal symptoms. Continued use leads to harder and more dangerous drugs like LSD and heroin.

Medico-legal implications are that majun and ganja was previously administered to victims to facilitate robbery. Marihuana, being a mild hallucinogen and narcotic is considered dangerous during driving.

Fatal dose is so large that neither suicide nor homicide is possible.

Plant Nux Vomica grows wildly and is highly toxic medium-sized tree native to India and Southeast Asia and a major source of the highly poisonous alkaloids Strychnine found in the seeds and Brucine in the bark of the tree. Its fruit is round in shape of the size of an apple, green to orange in color when mature and its cross section shows pulp containing seeds.

Its leaves are ovate and 2-3.5 inches (5.1-8.9 cm) in size. Seeds after removal from the fruit when ripe are then cleaned, dried and sorted. They have the shape of a flattened disk completely covered with hairs radiating from the center of the sides. This gives the seeds a very characteristic appearance. The seeds are very hard, with a dark grey horny endosperm where the small embryo is housed that gives off no odor but possesses a very bitter taste. Seeds are flat circular disc having convex and concave surfaces. The diameter of the seed is three quarter of an inch and thickness one-quarter inch. The color of the seeds is ash gray. (Photo.16.13) (Next page)

Entire seed after swallowing passes out as such without causing any effect. Poisoning occurs following ingestion of crushed seeds, which have its alkaloids. Strychnine is a deadly spinal poison and symptoms start appearing within 15 minutes of ingestion. It is slightly soluble in water. The solution is colorless, odorless and has a bitter taste.

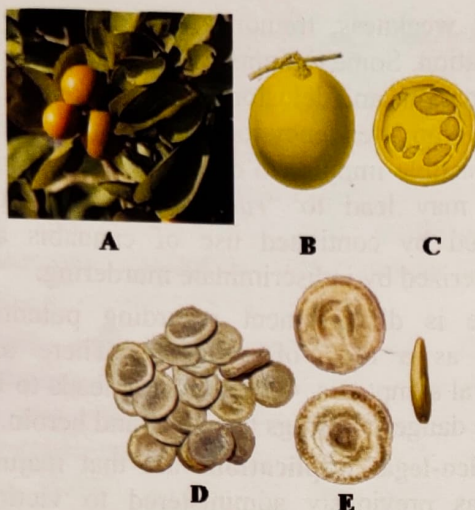


Photo.16.13: Parts of plant of *nux vomica*. A. Natural plant B. Mature fruit C. Cross section of fruit D. Bunch of seeds E. Magnified seeds

Fatal dose is 15 mg for children and 40-100 mg for adults.

Mode of action is stimulation of the central nervous system, particularly the anterior horn cells of the spinal cord. It greatly increases the reflex excitability. It does not stimulate neurons directly. Effects are the result of depression of inhibitory pathways. Inhibitory forces do not check excitatory neuron activity. It converts normal reflex neural activity into an explosive, convulsive force and slightest sensory stimuli induce convulsive seizure.

Sign and symptoms start either immediately or at the most after 15 minutes. Being bitter in taste, it increases gastric secretions. Muscles of the face and neck are first affected and they contract forcefully and become stiff, precipitating a characteristic grimace. Other signs are anxiety, restlessness, increased heart rate and blood pressure due partly to massive sympathetic discharge and due to extensive skeletal muscle contraction.

Strychnine induced convulsive seizure forces the back to go in hyperextension assuming arched position termed *opisthotonus*. In this position only the crown of the head and the feet touch the ground. All voluntary muscles including diaphragm, abdominal and thoracic are fully contracted. Respiration, which is increased initially, ceases during seizure. This produces central hypoxia. Most victims sustain two or at the most three convulsive episodes before death, which is caused by medullary paralysis.

Medico-legal implication is that it is an accidental poison for children being available in

every home in the form of tablets as rodenticide. Intentional suicide with such preparation in adults though possible yet is very rare.

Hydrocyanic Acid is volatile and a corrosive agent. Source of poisoning is vegetable fruits and commercial preparations. Most common fruits, which contain it in traces, are bitter almonds and certain species of peaches, and cherries. It exists in the form of glucoside amygdalin, which is harmless, but co-exists with an enzyme emulsin, which hydrolyses it and liberates hydrocyanic acid. Water is essential for this reaction. Salts of sodium, potassium and ferric cyanide are harmless, until they meet an acid to form hydrocyanic acid.

Hydrocyanic acid is extensively used in metallurgy, electroplating, photography and laboratory procedures. Available commercial preparations, which are used in veterinary practice, contain two and four percent pure hydrocyanic acid. It is also extensively used for fumigating purposes.

Hydrocyanic acid is weak acid and is soluble in water. Solution is colorless and quickly gets absorbed through gastric mucous membrane. Vapors of hydrocyanic acid have characteristic odor of bitter almonds and they are quickly absorbed through the lungs. Vapors are capable of absorption even through intact skin. Moisture facilitates absorption. Sodium and potassium Salts are solid and when these salts are ingested they mixed with hydrochloric acid in stomach and form hydrocyanic acid.

Mode of action of hydrocyanic acid is both local and remote:

- Locally it behaves as weak acid and cause irritation and hyperemia of the surfaces, it comes in contact with. It may also produce corrosion of mucous membrane of stomach.
- Remote action after its absorption is at the level of cell. It acts as protoplasmic poison inhibiting enzyme cytochrome oxidase and prevents uptake of oxygen by the cell. Interference with cellular respiration produces death of the cell. Tissues and organs, which are affected first by poisoning, are brain, blood, small blood vessels, skeletal and heart muscles.

Signs and symptoms are mainly due to anoxia of the cells. Anoxia of nerve cells of brain causes dizziness, unconsciousness and terminally convulsions. Anoxia of capillary vessel produces paralysis, dilatation, circulatory collapse causing flushed skin. Non-utilization of the circulating

oxygen produces rise in oxy-hemoglobin giving arterial and venous bloods pink color. Skeletal and heart muscles lose power of contraction and produce cardio-pulmonary failure.

Onset of symptoms with potassium cyanide is slower than with hydrocyanic acid and with hydrocyanic acid slower than its gas.

Fatal period is about 20-30 minutes with a toxic dose of 1 gm of pure hydrocyanic acid or salts of sodium or potassium are ingested. When gas is inhaled, death occurs in minutes.

If the victim is received alive in the hospital, gastric lavage with 1% Sodium Nitrate solution in warm water should be done immediately. Speed is essential or amyl nitrite by inhalation should be administered. It acts as an antidote by producing met-hemoglobin in blood. The hemoglobin itself does not combine with the cyanide to form cyan-hemoglobin. If met-hemoglobin is available, it readily combines with cyanide to form cyan-met-hemoglobin. This compound is non-toxic and is excreted as such through the kidneys. Artificial respiration must be given as long as heart continues to beat.

Collection of specimens requires precautions. Poison volatilizes even when in solution form. No time should be wasted in transmission of the organs to laboratory. Bottles should be closed tightly. Urine whole quantity and blood about 50 cc. should be collected. Other body organs are stomach and intestine with contents, liver, spleen and one whole lung.

Autopsy findings are due to its smell, local corrosive action to surfaces it meets and coloration of blood due to saturation of oxy-hemoglobin. Characteristic penetrating smell of bitter almonds is felt during postmortem examination. Standing near the dead body, for a while, dulls the sense of smell. Hypostasis and internal organ acquire pink coloration. Mucous membranes of the mouth and stomach show redness, congestion and corrosion.

Medico-legal implications are that it is a sure suicidal poison. *Herman Goring*, a General of Germany during World War II, on being taken as a prisoner, is believed to have taken a capsule of cyanide to commit suicide. Accidental poisoning keeps on occurring in industry. Cattle's poisoning also occurs. Homicide though rare but does take place. *Rasputin* could not be killed with a massive dose, because of alcohol-hydria from chronic alcohol intake.

Carbon Monoxide is widespread in domestic use. The gas is colorless, odorless and has specific gravity of 0.96. Sources are: (Table 16.3)

Table 16.3:

Sources of carbon monoxide

• Natural gas (Sui), when burnt in an unventilated atmosphere	
• Coal gas	--7-15%
• Water gas (while producing hydrogen)	--25%,
• Blast furnaces	--25-30%,
• Charcoal fires	--15-20%,
• Fire lamps (mines)	--0.5-1%
• Car exhaust fumes	-- 7%.

Relationship of percentage of gas in air to that of the blood is that:

- 0.1% of gas in air will produce blood saturation of 50- 60% in 2-3 hours
- 1% of gas in air will produce the above blood saturation causing unconsciousness in 12 - 20 minutes
- 7-15%, which is the percentage of coal gas is likely to produce fatal results in 2 - 5 minutes

Inadequate supply of O_2 and obstruction of ventilation by blocking door and ventilators results in partial or inefficient combustion which in turn produces CO and precipitates fatal outcome.

Mode of action is that CO has 200-300 times greater affinity for hemoglobin than O_2 . It is very rapidly absorbed through the lungs and rapidity depends upon its proportion in the air. It combines with hemoglobin to form carboxy-hemoglobin, which is cherry red in color, three hundred times more stable than oxy-hemoglobin and has rapid cumulative effect. It does not take part in O_2 transport and thus produce symptom of O_2 deprivations. Most important factor in producing anoxia is not the level of carbon monoxide in blood, but percentage of hemoglobin, which is inactivated from carrying O_2 . Exercise causes rapid breathing and children with rapid rate quicken the process of uptake. Being odorless, fatal level may be attained long before its presence is recognized. Leakage is more dangerous especially when smell is lost from filtration. Use of deodorants mask smell and is a factor for its non-recognition.

Fatal dose is variable, depending upon the physical health of the individual. Most people dying of uncomplicated poisoning have 65-75% in the blood.

Signs and symptoms depend on blood concentration. If concentration of carbon monoxide is less than ten percent, there will be no symptoms. One percent is found in nearly all people of average living, three percent in people living in industrial areas and five percent in smokers. Symptoms are variable whether onset of poisoning is **acute** or **chronic**:

- *Acute poisoning symptoms* start appearing at blood concentrations of more than thirty percent. If recovery occurs, it may leave certain residual confusion, depending upon the length of time during which brain remained anoxic. Amnesia and disorientation may occur. Degeneration and softening of the basal ganglia due to anoxia of brain may produce Parkinsonism. (Table 16.4)

Skin bullae develop in a person who remains unconscious during prolonged survival. They take the form of necrosis or ulceration which appear in areas of the skin under pressure and will take several hours to develop. Such lesions are also seen in barbiturate poisoning. It is important to distinguish them from thermal trauma.

Table 16.4:

Relationship of symptoms to carbon monoxide concentration in blood

Blood Concentration	Symptoms
30%	Confusion, fatigue, malaise, irritability, headache and giddiness
40%*	Nausea, sick feeling, vomiting, profound confusion, slight in-coordination and slurring of speech, unusual lethargy
50%	Marked confusion, in-coordination, drunken gait and ataxia
60%	Consciousness is lost, syncope, coma and in certain cases convulsion
70% & above	Deep coma, respiratory paralysis and death

*At this concentration even if the person feels that something is wrong, he is unable to do anything

- *Chronic poisoning symptoms* resemble those of psychomotor epilepsy. Such a patient has upto twenty-percent carbon monoxide. Level gets down rapidly in acute poisoning, whereas in chronic cases lowering is not easy. Carbon monoxide is bound up with tissues such as myoglobin and this is very slowly released.

Collection of specimen requires taking them both from the scene and the victim. Locally, the source of carbon monoxide is air sample collected by

gas engineers. An early sample is necessary for accurate diagnosis. From the victim blood is the specimen of choice.

Preliminary chemical test is done with 3% fuming acid and 5-10% sodium hydroxide. Blood solution containing carbon monoxide gives pink to chocolate to brown color with fuming acid and blood-containing carboxy-hemoglobin will remain cherry red, whereas oxy hemoglobin turns greenish brown.

Spectroscopic examination of carboxy-hemoglobin solution shows two absorption bands between D & F. Reducing agents like ammonium sulfate produce no change in the position of bands, whereas if the solution contains oxy-hemoglobin bands unite. A scaled spectroscope enables to measure the shifts produced with various concentrations. Method is very sensitive, reliable and accurate.

Gas chromatography is most sensitive and can detect very small amounts.

Medico-legal implication is that it commonly causes accidental poisoning at home affecting elderly people, because loss of their senses of hearing and smell. Defective memory about gas-taps is also a contributory factor. Cardiovascular disease and anemia may cause collapse at lower concentrations in advanced age.

Self-intoxication with domestic coal gas has been the most common method of committing suicide. Easy access and rapidity of its action were main reasons for its choice. Introduction of Sui gas has reduced such deaths. A person determined to commit suicide sets a classic stage by closing windows and doors and leaving a note of his intent and warning for others. Homicide poisoning is rare occurring only in suicide pacts. Its Possibility should never be excluded.

Autopsy findings present combination of anoxic and carboxy-hemoglobin color picture. Blood due to carboxy hemoglobin does not clot and is tinged with bright cherry red color. It also colors all organs of the body. Post-mortem staining is also of the same color. Differential diagnosis from poisoning due to hydrocyanic acid, nitrites and hypothermia is by chemical analysis.

Signs due to suboxia are manifested on the face, which is flushed. Veins on the neck are congested. Lungs and right side of heart engorged. Capillary permeability is increased and petechial hemorrhages are present on lung surface, pericardial tissue, skin

and conjunctiva. Microscopic examination of the brain shows hemorrhages in white matter and symmetrical necrosis of the basal nuclei. Skin shows blistering on the parts exposed to pressure, similar to those seen in barbiturate poisoning and other forms of coma.

Pesticides are compounds meant to kill pests both of plant and animal that interfere with man's health, comfort or economic well being. These compounds have two major groups:

- Insecticides, which kill insects
- Herbicide, which kill herbs

Pakistan being an agricultural country uses both of these drugs to maintain and increase its agricultural produce. Potential for poisoning with insecticides is much higher because these compounds are present in preparations like flea collar, fly paper and bug bombs as well as home and commercial sprays. Number of products containing pesticides is so great that if all of them were enlisted, it would run in thousands. Only two compounds, which have high potential for causing acute poisoning in the man, are:

- Organo-phosphorus
- Chlorinated hydrocarbons

Organo-phosphorus compounds are synthetic compounds and are highly toxic whether ingested, inhaled or absorbed through the skin.

Mechanism of action of these compounds is that they inhibit the action of pseudo-cholinesterase in plasma and acetyl-cholinesterase in red blood corpuscles and at synaptic junctions. Thus, acetylcholine level increases, which binds to muscarinic and nicotinic receptors in both central as well as peripheral nervous system.

Signs and symptoms of poisoning are muscarinic, nicotinic and central nervous system effects. Smaller doses produce only muscarinic effects and larger doses cause additionally both nicotinic and central nervous system effects:

- *Muscarinic effects* are salivation, lacrimation, urination and abdominal symptoms like cramps, nausea and vomiting. Effect on cardiovascular system is bradycardia leading to heart block.
- *Nicotinic responses* are fatigue, weakness, twitching, tremors and paralysis. Cardiovascular involvement leads to tachycardia and hypertension.
- *Central nervous system* symptoms are anxiety, restlessness, insomnia, confusion and in severe form, neurosis.

Medical treatment should begin immediately. In mild to moderate exposure 1 to 2mg of atropine sulfate per hour should be given intravenously up to 25-50 mg daily. In severe intoxication or following chronic exposure, aggressive measures and toxic doses of atropine are needed. Atropine sulfate 2 to 4 mg is repeated intravenously at five minute intervals until toxic symptoms of atropine become manifest. In case of dermal exposure in industry, clothing should be removed, skin should be washed with soap and water and eyes rinsed with plain water for about 15 minutes.

Medico-legal implications are that due to their strong and unpleasant taste, homicidal poisoning with organo-phosphorus compounds is uncommon. Accidental poisoning in adults in agriculture and industry and children is the most frequent incidence. Occasional suicidal cases are seen.

- *Chlorinated hydrocarbons* are also synthetic preparations and most commonly used is DDT. These compounds have low water solubility and for this reason, they persist in environment for a long time. Being soluble in lipids, they get deposited in the adipose tissue of the body and their excretion is slow at the rate of 1 % per day. Chlorinated hydrocarbons are, thus safer than organo-phosphorus compounds.

Mode of action in causing toxicity is unknown. However, they are classed as neurotoxic and brain is the main site of action, having effect on both sensory and motor nerve fibers and motor cortex.

Signs and symptoms are nausea, vomiting, paraesthesia of tongue, lips and face, restlessness, irritability, tremors and convulsions. Death results due to respiratory failure.

Kerosene Oil is an extracted and refined form of rock oil, petroleum. It is a domestic item available in almost every house in rural area. It is absorbed from intestines if ingested and lungs when inhaled as vapors.

Mode of action is both local and remote:

- *Locally* it is an irritant. Symptoms when ingested include nausea, vomiting.
- *Remote action* after absorption is mainly on the central nervous system. When large doses (1ml/kg body weight) are ingested, symptoms of central nervous system depression followed by those of irritation occur. Patient feels weak and dizzy and his respiration becomes shallow and rapid. Victim eventually becomes unconscious.

Signs and symptoms differ in acute as well as chronic intoxication.

Acute intoxication manifests with first symptom usually noted by mother are that child is restless, has difficulty in respiration and his body temperature is raised. While excretion, which is mainly through lungs, it causes pulmonary irritation, bouts of cough and difficulty in respiration and produces pulmonary edema. Bronchial secretions contain blood and victim eventually develops pneumonitis leading to acute pneumonia and hyperpyrexia. If recovery is delayed, chest complications in the form of emphysema and pneumo-thorax develop.

Fatal dose is variable and depends upon age, physical health and susceptibility of individual.

Chronic intoxication occurs from prolonged exposure. It manifests with signs and symptoms of dizziness, weakness, loss of weight, anemia, aches and pains in the limbs, peripheral numbness and paraesthesia.

Medical treatment of acute intoxication is by administration of 250 ml of liquid paraffin in adults given orally to halt its absorption followed by gastric

lavage with saline. When extensive quantities (4-ml/kg-body weight) have been ingested, stomach wash with warm water containing sodium bicarbonate is done with a cuffed endotracheal tube in place to prevent aspiration into the lungs. Antibiotics should be given to prevent and treat pneumonia. In case of poisoning by inhalation of vapors, the patient should be removed immediately in open air and artificial respiration supported with oxygen is given.

Autopsy findings are nonspecific. There may be smell of kerosene oil while opening the chest and abdomen. Lungs are edematous, and there may be signs of asphyxia. Specimens collected are blood, urine, stomach wash (if the victim is alive) and additional specimens of stomach and small intestines with contents in place of gastric lavage, portions of liver, spleen, kidney and one whole lung.

Medico-legal implications are that accidental poisoning in children as acute intoxication commonly occurs. It can also be taken intentionally by adults to commit suicide. Homicide is not possible because of its smell and taste.

17. Laboratory Services

Forensic laboratory services are of diverse nature, which are needed during police investigation. They are required to establish personal identity, determine weapon-assaults relationship, confirm origin of biological material in sexual assaults and categorization of accidents weather in industry or transportation on road, rail or in air. Besides a major chunk of work is to know the nature of poison administered, ingested or other toxins such as pesticide, insecticide or heavy metal entered and circulating in blood in body of a worker or residents of vicinity, where industry is located. The letter work requires essentially analysis of body fluids like blood, bile, urine and stomach/intestine contents and organs such as liver, spleen and kidney forming route of poison.

It is emphasize that existence of such services is legal requirement being public necessity and requiring maintenance of proper chain of custody of collected samples from victims to investigating laboratories and incorporation of results of analysis in final forensic medical certificate for submission to investigating agency/court. Indeed the work is of higher responsibility requiring standard proof.

Model of existing forensic laboratory services were introduced in 1858 by English after consolidating their hold over Indian sub-continent. Arrangements made then belonged to *Partial Laboratory System* and were make-shift-type allocating additional forensic duties to teaching departments of Anatomy, Bacteriology and Entomology at King Edward Medical College, Lahore and also designating head of the department as anatomist, bacteriologist and entomologist to Government. Such arrangements were neither functionally independent nor updated. Further, heads of medical departments showed no interest in allocated additional forensic duties, which it deserved. It have resulted in half-hearted performance of forensic investigations lowering standard of work and eventually adversely affected administration of justice. Besides *Chemical Examiner Laboratory, Lahore* and serologist to the government was establishment and allocated responsibilities of chemical and semen analysis for cases of poisoning and sexual assault.

These arrangements continued till 1947, the year of division of India into two separate and independent States of Pakistan and Bharat and

further on till 1975 when first independent scientific department of forensic medicine was established at King Edward Medical College, Lahore. Recent efforts made by Punjab government to further improve forensic services in Punjab, Lahore have resulted into establishment of two autonomous institute/laboratory namely Punjab institute of blood transfusion for forensic serology and Punjab Forensic Science Laboratory for determination of DNA. Both laboratories are headed by independent Directors. (Table 17.1)

Table 17.1:

Forensic Science laboratories

Inherited forensic arrangements introduced by English

<i>Name of the Institution</i>	<i>Allocated additional duty</i>
1. Professor of Anatomy, KE Medical College, Lahore	Forensic Anatomy
2. (a) Professor of Bacteriology, (b) Professor of Entomology College of Community Medicine, Lahore	Forensic Bacteriology Forensic Entomolog
3. Chemical Examiner, Lahore	Chemical and semen Analysis

Forensic science laboratories added by Punjab Government

1. Director Blood Transfusion Punjab Lahore	Forensic Serology
2. Director Forensic Laboratory DNA Punjab Lahore	

Forensic evidence may be defined as any material found at crime scene or collected from body of victim or assailant. Most important forensic evidence is human blood, which gets split on floor or furniture and stains cloths of the victim/assailant and weapon of offence. Other important forensic evidence is human semen jetted and deposited in vagina and anal canal during sexual assault and also staining cloths. Biological hair human is also important, which gets rooted out and sticks to cloths and body of victim and assailant during sex-play. Non-biological fiber is new addition to the list of forensic evidence due to growing use of artificial materials. Poison contained in body fluids like blood, bile, urine and also body organs like liver, spleen and kidney has impotence in its own right as forensic evidence of poisoning.

Purpose of examination of forensic evidence is to first establish its identity and then confirm its source from where it has come by comparing with its control taken from suspected source. It is usually found in small amounts (traces). *Trace evidence* is tell-tale material such as blood, semen, hair, fiber, glass pieces and grit particles, which is found at scene of crime, body of victim or assailant. It originates from two types of sources **biological** or **non-biological source**.

Biological source includes body fluids like blood, semen, saliva, cerebrospinal fluid, vomit, stomach wash, urine and excreta or other tissues such as hair and nails. Such fluid in the form of stain is found at crime scene, body skin or orifices of urethra, vagina and rectum of victim or assailant. Other material of human origin is hair from head, eye-brows, pubes and scrapings from under surface of nails containing skin epithelium collected during physical or sexual assault.

Non-biological group comprises of items of personal use of victim or assailant and things found in the environment. Personal use items consists generally of possessions such as spectacles, wristwatch, purse and things in pockets and things found in the environment are wool fiber from carpet, vegetation from garden like leaves, grass, seeds and grit particles from road. This group may also include implements concerning commission of crime such as weapon, component of ammunition like empties, bullets/pellets and bottles or medicine tablets.

Edmond Locard (1877-1966) formalized trace evidence exchange on scientific lines, useful for determination of personal identification, as *Locard's exchange principle* laying two principles of exchange:

- Every contact leaves a trace
- Exchange of trace may be and often is two way process

During forensic autopsy at author's department of alleged case of zina with a female child and killing by strangulation, samples collected from scene of crime, bodies of victim and assailant were examined:

A. Crime scene

i) Vegetation seeds (collected and sent by police)

B. Body of victim

i) Vaginal swab

ii) Trapped vegetation seeds from victim's head

iii) Blood as control

C. Body of assailant

i) Pineal swab

ii) Blood as control

Results confirmed commission of crime of zina at crime scene and transfer of vegetation seeds from crime scene to victim's head, assailant's semen into victim's vagina and victim's blood to assailant's penis. (**Photo. 17.1**)



Photo 17.1: "Vegetation seeds" from crime scene to victim's hair and death by strangulation

Once collected forensic evidence reaches laboratory, carefully go through information sent with it. Adopt necessary procedure in order in which they are to be carried out. Procedure may vary from case to case. Recommended scheme starts with physical examination of the specimen and its vehicle, followed by isolation of material from the organic material. Then is the turn of application of special techniques for the determination of its nature and concentration.

Forensic evidence identification from earliest time depended upon use of five personal faculties namely vision, hearing, smell, taste and touch to know its qualities for intelligent interpretation. Same principle is recommended for examination of forensic trace evidence identification whether a stains of blood, semen or a part of bone. First it is examined physically at site of recovery recording its full description. This examination is followed by a special procedure in the laboratory as in the case of a stain, which requires technique for its isolation from its vehicle. It is only then other tests such as chemical reactions; microcopy and immunology can be performed on the material of staining. Results of examinations should be tabulated and presented on a standard Performa that may be understood easily by both police and law courts. Various types of forensic evidence will be discussed one by one.

Blood and its identity in a stain depend upon the presence and recognition of red and white blood cells along with its other constituents. Total volume of blood in a person of average built is 5-6 liters, which is about 8% of his total weight. From the point of view of identification, red blood cells and while blood cells are of great medico-legal importance. Red blood cells contain hemoglobin pigment, which is responsible for red color of a fresh stain on white cloth. This red color gradually changes from *red to brown, which darkens with time*. Against a gray background, a fresh bloodstain appears dark brown. White blood cells help in determination of sex due to presence of sex chromatin in females.

After being exposed to the external environment, the blood coagulates and when the smear is thin, it dries quickly. Dried bloodstain get preserved. If the stain is damp, there is a greater likelihood of bacterial growth, which interferes with its detection. The presence of blood can only be established when tests for hemoglobin and human proteins are positive. Blood stain should be subjected to the following three examinations:

- **Physical examination**
- **Chemical examination**
- **Spectroscopic examination**

Physical examination includes inspection with naked eye and under ultraviolet lamp and palpation of the stain

i) *Inspection with naked eye* reveals its color and shape. Color may be red and shape as irregular map-like, streaks or drops indicating the mode and direction of deposition from which it has come. Blood drop falling vertically on to a flat surface makes a rounded spot with crenate margin if the drop has traveled for some distance; drop arriving obliquely at the surface will produce a splash in the shape of an exclamation mark "!". Smaller spot pointing the direction in which the blood was traveling. Color of blood stain is first purple-red, gradually changing to brown color, which deepens. Rate of change depends upon the thickness of the stain and other conditions to which the stain is exposed. A stained cloth when washed retains faint yellow color. The staining by fruit or vegetable juice, aniline dyes, and iron rust may simulate the color of blood.

Under ultraviolet lamp it appears opaque. (Fig. 17.1)

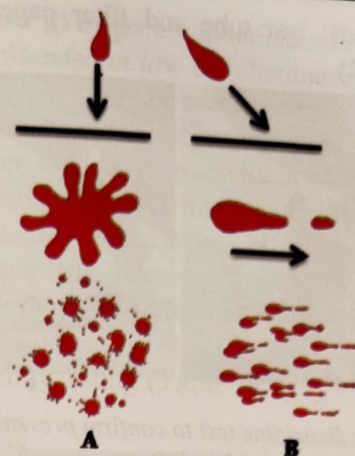


Fig. 17.1: Blood stain interpretation. A. Falling vertically. B. Splashing obliquely

ii) *Palpation of the stain* assesses degree of moisture or extent of drying to make an estimate of time elapsed. Cloth with dried bloodstain is stiffer than the unstained cloth.

Chemical examination of the blood stain pre-requires preparation of extract from stained and unstained portions, to act as control. A reagent should never be added over the garments, as it would interfere with all subsequent tests. Preparation of extract needs a piece of stained portion, especially the one having a thick stain or a clot is cut and placed in a watch glass with a few drops of water and covered with another watch glass and allowed to soak. If the stain is fresh, solution forms rapidly in about 10 minutes. An old stain may need 24 hours. No attempt should be made to hurry the process by manipulations. Prepared extract is placed in a test tube. The most common *screening tests* performed on the extract are **benzidine**, **leuco-malachite green** and **phenolphthalein**:

Benzidine test requires 10% benzidine reagent. Take the stain extract on a watch glass, add a few drops of benzidine reagent and then add a few drops of hydrogen peroxide. A positive reaction is indicated by the formation of blue color. This color reaction is due to oxidation of the colorless benzidine base into blue salt. Peroxidase in blood acts as a carrier of oxygen from hydrogen peroxide. Most oxidizing agents such as bichromate, permanganate give strong reactions without addition of hydrogen peroxide. A positive reaction is also obtained with pus, other body secretions, certain fruit and plant juices and many commercial formations. It is not a definite test of presence of blood. When negative, blood is certainly not present in the stain. Its value lies in its negativity. There are

two methods; test tube and filter paper method. (Photo 17.2)

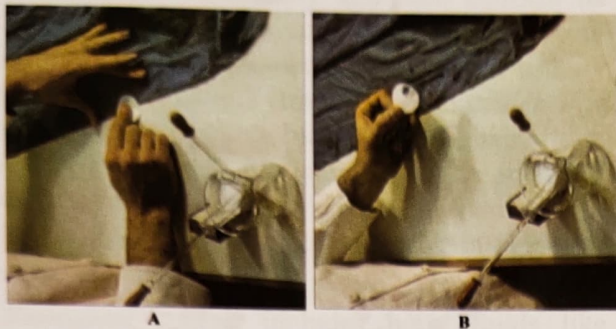


Photo 17.2: Benzidine test to confirm presence of blood with filter paper method A. Filter paper rubbing over an area of the shirt suspected of being bloodstain B. Filter paper treated with benzidine solution shows intense blue color

Leuco-malachite green and *phenolphthalein* tests are performed as that for benzidine test. The stain extract is mixed on a watch glass with respective reagents. Addition of hydrogen peroxide gives positive reaction indicated by appearance of bright green and pink colors respectively. The tests are more specific but not as sensitive as benzidine test.

Screening tests should be followed by confirmatory tests on blood stains namely Takayama or hemo chromogen crystal test, spectroscopy and microscopic examination.

Takayama test detects characteristic pigment *hemoglobin* in the blood. It is a micro chemical test. It is performed by placing a small fragment of the suspected stain on a glass slide, adding the reagent to it and covering with a cover slip. The slide is warmed gently for a few seconds to activate reaction and then examined under a microscope to note clusters of feathery brown crystals (Photo 17.3)

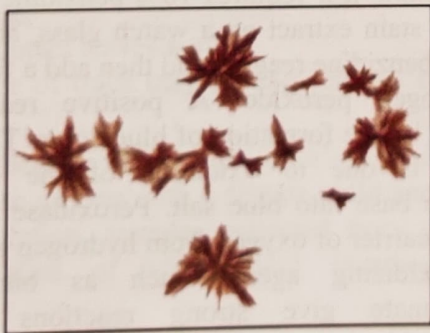


Photo 17.3: Micrograph showing positive Takayama micro-crystals

Spectroscopy of blood stain is based on the principle that blood pigment is quite stable and has the property of absorbing light of certain

wavelength. When light is passed through the extract placed in a spectroscope, depending upon the condition of hemoglobin compound in the extract, specific absorption bands are observed in different parts of the spectrum:

- Oxyhemoglobin is present in fresh extract and shows two absorption bands between D and E lines
- Reduced oxyhemoglobin produced by the addition of ammonium sulfide in fresh stain shows one single broad band between D and E lines
- Reduced hematin is made by the addition of a drop of 30% NaOH in the above fluid by converting the reduced hemoglobin and its spectrum shows two bands, one midway between D and E, and the other just on the left of the E
- Methemoglobin is present in old stain, which is brown in color and shows four bands, two similar to oxyhemoglobin, third in C and D and fourth beyond E line (Fig 17.2)

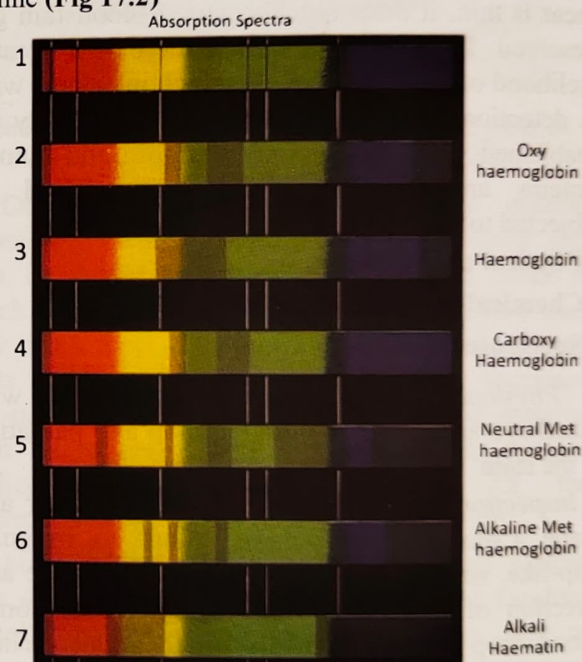


Fig 17.2: Absorption bands in different parts of the spectrum

Microscopic examination is confirmatory test based upon study of morphology of blood cells. For its performance, it requires preparation of a good slide having thin film. A small portion of stained cloth is placed on a glass slide and solvent is added to it. The fluid used should be isotonic with serum to avoid destruction or distortion of the blood cells. Cloth is teased gently with a needle and spread thinly onto the slide. The film is air dried, fixed in alcohol and stained with hematoxylin and eosin. The stained film is then examined under the microscope. Red blood cells in old stains are generally altered or destroyed and cannot be recognized.

Red blood cells of mammals are circular and non-nucleated except those of camel. Red blood cells of birds, fish and amphibians are oval and nucleated. Size of the red blood cells is species specific to some extent. (Table 17.2)

Table 17.2:

Sizes of red blood cells of different species

Species	Size (um)
Human	7.5
Cat	6
Goat & Sheep	4
Deer	2
Frog	22x15
Pigeon	14x6

Nuclear morphology of white blood cell and buccal epithelial cell helps differentiation of the sex of the source. Thirty percent female white blood cells show drumstick shaped Davidson body and buccal epithelial cell Barr body. Other foreign cellular material of significance is either a flattened pus cell when bloodstain has come from a boil or endometrial and vaginal epithelial cells. **Photo.17.4 & 17.5)**

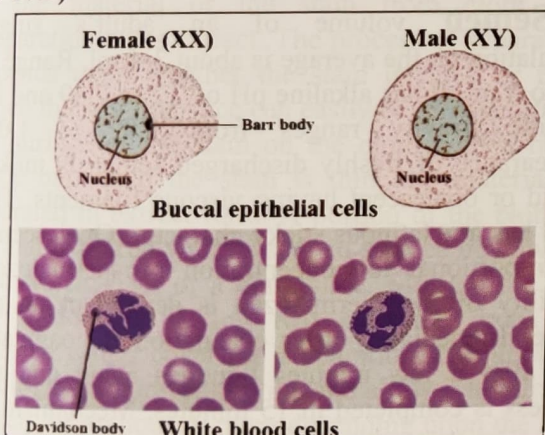


Photo.17.4: Nuclear morphology of buccal epithelium and white blood cell showing barr and davidson body



Photo. 17.5: Slide showing nucleated epithelial cell along with two human spermatozoa

Blood groups are inherited characteristically obeying *Mendelian law* of inheritance that a blood group gene (antigen) cannot appear in a child, unless present in one or both parents and if one of the parent is homozygous for a particular blood group gene (antigen) it must appear in the blood of the child. There are many blood group systems, which have been developed over a period of time. Currently they are applied in medico-legal practice for determination of blood groups of blood stains and paternity testing (Table 17.3)

Table 17.3:

Blood group systems

Red blood cell based	Serum based
ABO	Haptoglobins
MNS	Gm
Rh	Gc
Duffy	
Kidd	
Kell	
Lutheran	

Blood group antigens are situated in the outer envelope of red blood cells and antibodies are present in the serum of blood. Formation of antigen is controlled by genes, which are present in nuclei of all cells. Each parent contributes half of each pair of homologous chromosomes carrying single allele. Fertilization restores the normal number of chromosomes.

Each allele pairs with its counterpart on the homologous chromosome form a gene. A child is called homozygous for a particular gene, if the alleles contributed by each parent are similar; and called heterozygous, if the contributed alleles are different.

Determination of blood group is based on antigen-antibody reaction, which is generated by mixing the red blood cells with appropriate antisera and noting the *agglutination* or *clumping*. There are two methods:

- **Direct agglutination**
- **Indirect agglutination.**

Direct agglutination is carried out by three techniques; ring test, gel diffusion and immunoelectrophoresis.

i) *Ring test* is dependent upon reaction between specific characters of serum proteins, prepared by injecting a rabbit with large doses of human blood. The serum of the rabbit is collected which, on mixing with human blood will give a precipitate reaction. Ring test can be demonstrated either on a

glass slide or in a glass test tube. Positive reaction is indicated by the formation of a cloudy precipitate on the slide or in the test tube in the form of a cloudy ring or a band at the junction of specific anti-human serum and blood. (Fig. 17.3)

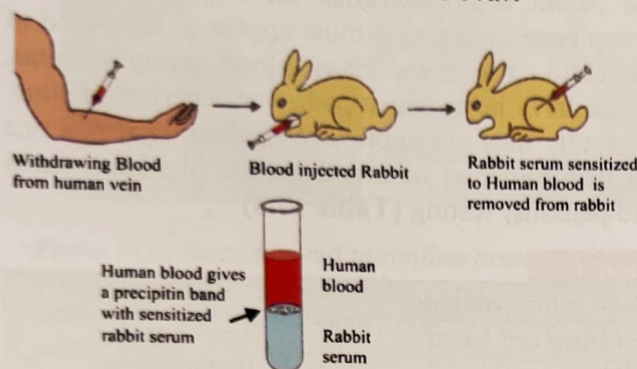


Fig. 17.3: Principle of ring test

ii) *Gel diffusion* is more useful than the ring test. Stain extract containing human globulin and specific serum containing anti-human globulin is poured into wells on a slide with a pipette. Anti-human globulin is placed in one and the extract in another well. Bands of precipitate reaction are noted. (Fig. 17.4)

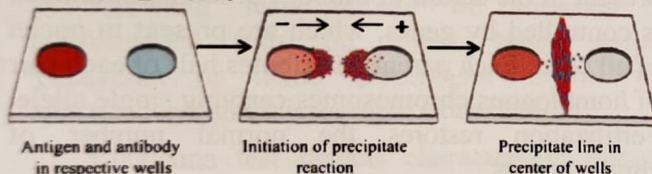


Fig. 17.4: Precipitate reaction in gel

iii) *Immuno-electrophoresis* is precipitation in which reaction is aided with the passage of electric current. Extract contaminated with fat gives good results. The test is more sensitive than ring and gel diffusion.

Indirect agglutination is based upon absorption of a standard anti-globulin reagent by a globulin contained in the extract of the stain. The strength of antiserum is measured both before and after it is mixed with the stain extract. Any reduction in titer of anti-globulin caused by its absorption by globulin contained in the stain is indicated by red cells coated with globulin. Method is a specialized technique and the minimum requirement is that the blood group antigen in the stain must be capable of absorbing the inhibitory activity. Toughest antigens are those of ABO and they remain detectable for years. MN antigens remain active for maximum nine months. Rh antigens become inactive usually within six weeks.

Mixed stains like blood of one mixed with saliva of another or semen mixed with vaginal fluid are most difficult to group. Gm factor can be demonstrated even after several months as this factor is usually not present in semen and saliva and its apparent absence in these fluids makes it possible to obtain the correct Gm grouping of the blood stains which are suspected of contaminated by these fluids.

Blood stains, when presented to the laboratory are usually in a dried state and may be contaminated. Direct agglutination tests are not possible in these stains since red blood cells are destroyed and blood group substances are in soluble form. Draw backs are that the material is limited and the stain may be contaminated and subjected to bacterial destruction. Negative results in such cases may either be due to true absence of the group substance or due to damage caused by the unknown conditions a stain may have been exposed to. It should be made very clear that only positive results are of real value and that too for their negative significance.

Semen volume of an adult's single ejaculation on the average is about 3-4 ml. Range is 0.5 to 6 ml. It has alkaline pH of 7.2 to 7.39 and its specific gravity ranges from 1.02 to 1.04. Appearance of freshly discharged semen is milky, turbid or opalescent having viscous filaments. The fluid has a gelatinous sticky character. Opalescence is proportional to concentration of spermatozoa. Motility of the spermatozoa is dependent on pH value. Immediately after ejaculation it coagulates and after a few minutes liquefies again and the process is completed in 15 minutes. Mechanism of this coagulation is not known. As regards its composition, it consists of fluid portion and formed cellular elements. Fluid portion has a high quantity of prostatic secretion, which is rich, both in acid phosphatase enzyme having 4000 to 8000 units per ml. in contrast to other body fluids and crystals of choline. Formed cellular elements are spermatozoa and epithelial cells. The presence of the enzyme and choline crystals can be proved by chemical reactions and formed cellular elements by microscopy.

Seminal stains when presented to the laboratory are usually in dried state and may be contaminated with vaginal secretions or fecal matter. There are four types of laboratory examinations of seminal stains:

- Physical examination
- Chemical examination
- Microscopic examination
- Serological examination

Physical examination is to note color, shape and age (duration) of the stain and it is done in three steps:

i) *With naked eye* seminal stain appears as an irregular map-like area having brown or yellow to light gray color. On light-colored fabric, it presents as a grey depression below the level of the cloth whereas on dark color material it has a whitish glistening appearance. Vaginal discharge and urine stain white cloth yellow and fecal stains brown.

ii) *Under filtered ultraviolet light*, the stains of urine, vaginal discharge and semen show bright fluorescence. The fluorescence of seminal stain is bluish white in color.

iii) *Palpation of seminal stains* is to note presence and extent of moisture in the stain to assess its age. Dried stains impart a stiff feel.

Chemical examination pre-requires separation of the material of the stain from cloth and preparation of its extract. The process of separation depends upon whether the stain is thick or thin. When thick, a fine slice can easily be removed from the surface of the stain on the cloth with a razor blade but when the stain is thin, the material is separated in extract form. A portion of the cloth is cut and is placed with its stained surface downward on a watch glass or a glass slide. Moisten the cut out portion by adding two or three drops of acidified water, cover the preparation with another watch-glass to prevent drying and allow it to remain soaked for an hour or more depending upon the age of the stain. The piece is then grasped with a pair of forceps and squeezed or pressed gently on a few slides. The slides are allowed to air dry and the ones with the thin film are reserved for microscopy and others for chemical tests.

i) *Acid phosphatase test* is a screening test. Principle of test is that the phosphatase enzyme has the ability to split aliphatic and aromatic orthophosphoric acid esters and working reagent consists of sodium chloride 23 gm.; glacial acetic acid 0.5 ml.; trihydric sodium acetate (anhydrous) 2 gm.; bromamine fast blue B salt .50 mg.; calcium and naphthalene phosphate 50 mg.; aerosol 1% one ml.; and distilled water 90 ml.

Technique of test is that prepared slide is sprayed with working reagent. After a short

interval, if the enzyme is present, there will develop deep pink color with blue tinge. A false positive result may be obtained with feces and contraceptives, but the color appears more quickly and is much lighter. With semen, there is some delay and this time interval is specific of enzymatic reaction. The amount present may also be calculated by colorimeter.

ii) *Florence test* detects choline. A cover-slip is placed over the stained portion on the slide. A drop of Florence reagent in water containing potassium periodide and iodine is added. It is allowed to run under cover-slip and the slide is examined under the microscope. Reaction is immediate and appears first on the edges and then throughout showing cluster of crystals of choline periodide, which are similar to hemin crystals, but are larger in size. Negative results may be due to low content of choline. (Photo.17.6)



Photo.17.6: Florence test showing **A.** crystals of periodide of choline **B.** Hemin crystals for comparison

Microscopic examination depends upon condition of the stain, preparation of a good slide having very thin smear and proper staining. The smear on the slide is first fixed with methyl alcohol and then stained with hematoxylin and eosin. Hematoxylin stain is applied first for 20 minutes; the slide is washed in running water for 30 minutes and then counter stained with 3% eosin for three minutes. Again the slide is washed thoroughly, dried in air and treated with increasing concentrations of absolute alcohol.

Examination of the slide is done under high power preferably in cedar wood oil (Canada balsam) with oil immersion lens. Human spermatozoon, which has head, neck (mid piece) and tail (filament) may be seen. Head is about 4.5 microns in length, about one tenth of its total length and looks oval when seen flat and pear-shaped when viewed in profile. Neck and tail is about 50 microns. Stained slide shows sperms double staining. Head and a portion of neck appears red and rest blue. Very often only head or immature sperm cells in different stages of development may

also be seen instead of fully developed sperm. (Photo.17.7)

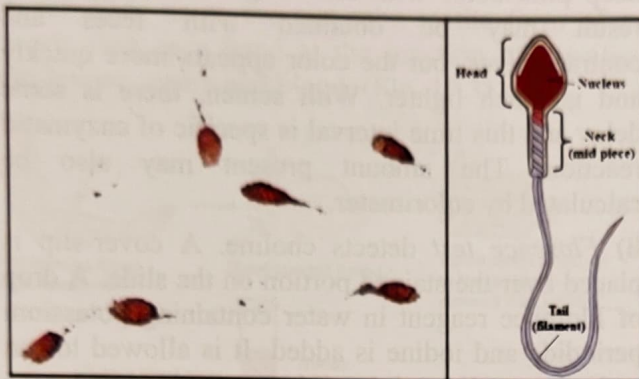


Photo.17.7: Photomicrograph of human spermatozoa

Contamination of stain with vaginal fluid may show squamous cells in addition to sperms. Cells from prostate and certain fungi and variety of monilia may also be seen. Such cells resemble spermatozoa. Ready differentiation from sperm may be made by their staining reaction.

Fecal stain on microscopy will show undigested muscle fibers and minute particles of plant tissue. A test for urobilin should also be done. In actual practice, when saliva, blood, semen and vaginal stains are found contaminating each other, it would be necessary to make available full facts of the case and fresh control samples of blood and saliva from the person known to be involved for proper interpretation of the results.

Serological examination of seminal stains pre-requires preparation of good extract and availability of specific anti-human precipitin serum. Small pieces of the stained material are cut and allowed to soak in normal saline in small test tubes for variable periods depending upon the age of the stain. Fresh stains need 20 minutes and older stain may require hours. The amount of saline varies according to the size of cut out material, but it should be kept to the minimum about 0.25 ml. After soaking, these pieces are picked up with forceps and squeezed and fluid collected against the wall of a test tube. The tube is then subject to rapid centrifuge for a few minutes. The supernatant fluid is separated for precipitin test using specific anti-human precipitin serum. The ABO grouping from secretor individuals does not present difficulty. Absence of a reaction against all the three ant-sera (Anti A, B, & D) means that the individual is either a non-secretor or the stain has been denatured.

Hair examination is not confined to the study of detached or isolated hair, but extends to

hair bearing areas, which may be valuable in the establishment of age and sex. As a medium of personal identity, hair is disappointing, but its role to establish identity in human remains, in associating a suspect to a particular crime or between the victim and a weapon is important. A hair has a root, follicle, shaft and a tip or free end, each having their characteristics.

When viewed under the microscope, the shaft structurally consists of three tube-like layers one over the other; cuticle, cortex and medulla. The cuticle or the surface layer is composed of scales each overlapping the next similar to the scales of a fish. The cortex is the intermediate layer and contains the coloring pigments. The medulla is the central portion and varies with the type of hair being human or animal. Microscopic examination of all the three portions reveals their characteristics, which help determination of the source. (Photo.17.8)

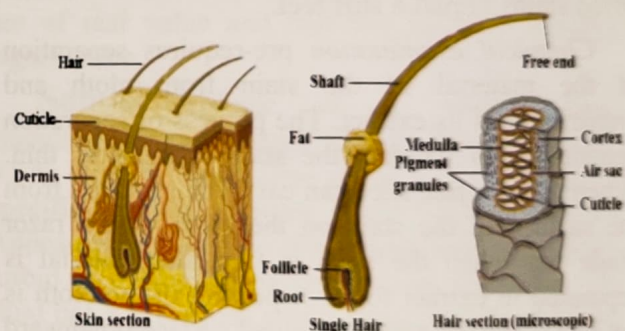


Photo.17.8: Structure of a typical human hair

Human hair as an evidence for age and sex depends upon its character and distribution on various parts of the human body. Human fetus and newly born children are hairy with even distribution over the trunk, which consist typically of fine, soft and inconspicuous hair without pigments, smooth scales and free edges, forming a less complex scale pattern. They are gradually replaced by coarser hair, which are pigmented, modulated and have a more complex scale pattern.

Regional growth of hair of scalp, eye lashes and eyebrows are present before birth. Additional aggregations of hair appear at pubic and axilla during puberty. Finally, there is increased hairiness of the face, limbs and trunk in males. With advancing age, loss of scalp hair in men and axillary hair in females occurs. Increase of facial hair at menopause may occur in a certain percentage of females.

Age and color of hair are also related. Distribution and character of hair on a mature individual indicate sex. Upper border of pubic growth is horizontal or concave in females and rises up to umbilicus in males. Male hairs are denser, coarser and darker. Physical examination of a skin piece without hair in the case of human remains should be supplemented with histological examination to note any hair follicles.

Microscopic examination, prior to introduction of man-made fibers was the only tool to differentiate human hair from wool, cotton and silk fibers. Man-made fibers have increased complexity of identification. Under the microscope, a synthetic fiber has uniform rod like structure and section examination is not helpful. Identification is based on the staining of the fibers, methods available for removing the stain, differential solubility and other physiochemical properties such as density, softening point by temperature and application of modern methods of infra-red spectroscopy. (Fig. 17.5)



Fig. 17.5: Photomicrograph of cotton fiber

Forensic histopathology examination

is one of the essential further examinations. It deals with macroscopic as well as microscopic examinations of a body part, an organ or a portion of an organ having a defect, disease or injury which is removed during forensic autopsy. This examination provides, amongst other information, evidence of disease, which may have precipitated sudden death or may help in assessing effect of drug, physical exertion and trauma including psychological stress on fatal outcomes. This objective is achieved by noting morbid anatomical changes in the body organs supplemented with information derived from histology and other techniques adopted in the laboratory. Specimens collected during forensic autopsy are preserved in 10% formal saline and sent under sealed cover along with autopsy report for further examination to authorized laboratory.

Received specimen in the laboratory is subjected to both **naked eye examination** and for **histology** and **histo-chemistry** after proper processing.

Naked eye examination includes noting change of size, color, consistency and condition of covering in body part or an organ. Findings are entered in

report performa of the register. In case only a portion of an organ bearing pathology is received and detailed gross examination is unrewarding, the tissue is processed straight away for histology.

Histological examination of the suspect area requires preparation of slides. Tissue bearing pathology is located and cut out along with some healthy tissue for comparison. Cutting should be done from the margin of the lesion to include some healthy area. Selected tissue is fixed, sections prepared, placed on slides, stained and examined under the microscope.

Buffered formal saline is a good fixative to mummify the tissues and suppress autolysis. Choice of fixing agent depends upon the purpose for which the tissue is to be preserved or stained. Other fixatives are alcohol and acetone but they are expensive. Specimen is placed in a container having 10% fixative solution and is kept dipped overnight. Soft tissues like liver, spleen and brain are cut in 2 cm thick slices and placed in a more concentrated fixative for better results. Fixing of specimen can be done manually or using automatic tissue processor. Use of automatic tissue processor has improved working. Automatic tissue processing unit is a machine having a basket for holding tissue sections and several beakers containing different specific fluids. The basket carrying tissue sections dips automatically in beakers for preset timings. The advantages of use of automatic tissue processors are efficiency, economy of chemicals due to less evaporation and accurate fixation timing. (Photo.17.9)



Photo.17.9: Automatic tissue processor

Methods to prepare sections depending upon urgency of the case are two:

- **Formaline-fixed-paraffin-embedded section**
- **Frozen section**

Formaline-fixed-paraffin-embedded section is prepared after embedding the formaline fixed tissue

in paraffin. Since paraffin does not mix with water, the tissue must be dehydrated first and then cleared in a solution, which is miscible with paraffin such as alcohol. Paraffin blocks are placed at an appropriate place in the microtome for cutting of sections. The section should not be more than 4 p thick. Mounting of the section onto the glass slide is done by smearing the slide with an adhesive solution and taking the section on it in the center by lifting the section floating in the microtome dish and leaving it to dry. (Photo.17.10)

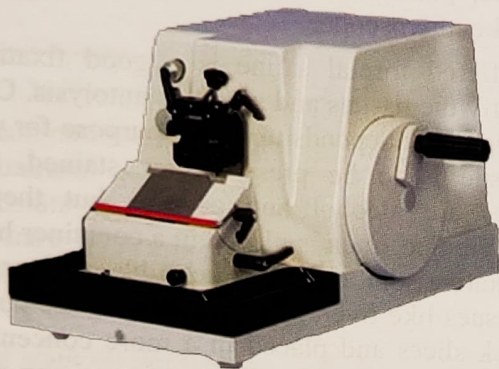


Photo.17.10: Table mounted Rotary microtome

Frozen sections are generally prepared when histological reporting is demanded within a few hours. Formaline fixed block is washed with water and processed in degrading concentrations of alcohol before storing in liquid nitrogen. It is, then, adequately frozen for 5-15 minutes using cryostat machine having temperature control between 400 to 700C. This machine has built-in microtome to prepare 5 p thick sections. These sections get fixed to the glass slides without adhesive solution by leaving them on the slide at room temperature. (Photo17.11)



Photo17.11: Floor-mounted Cryostat

Slides bearing sections are stained either manually using hematoxylin and eosin stains or with the help of automatic tissue-stainer (timer monitoring). All slides are scanned for relative comparison among the histological evidence of different sections from other organs of the same cadaver and gross and autopsy findings. (Table 17.4)

Table 17.4:

Scanning observations

- Normal histology of tissue
- Degree of autolytic change and its effect
- Relevance between history and lesions
- Status of blood vessels
- Identification of nature of pathological change
- Severity of pathological lesion versus causation of death
- Estimated duration of pathological process
- Confirmation of pathological lesion being the cause of death
- Aggravation of already existing disease due to trauma
- Evidence of any tumor irrespective of being cause of death or not
- Typing, grading and staging of the tumor

Results in both paraffin embedded and frozen sections are equally reliable. Main disadvantage of formaline fixed-paraffin-embedded section is time required for the preparation, which is seldom less than two days.

Histo-chemistry provides the most sensitive and earliest demonstration of tissue changes and in most cases within 2- 4 hours after the onset of disease. This procedure is extremely useful in the diagnosis of myocardial infarction. The rationale of the technique is to allow the surface of the tissue to be incubated in contact with a substrate containing a fluid (indicator). The dead or ischemic cells have a reduced or absent dehydrogenase activity and therefore these areas of the section remain unstained.

Findings observed on gross and microscopic examinations of all the viscera should be entered on the prescribed Performa of the register by Forensic Histo-pathologist in his own handwriting. Conclusion should be based upon history, gross and microscopic findings. Two copies, an original and a carbon copy, should be prepared vide the number allotted to the case. Original copy of the report is retained in the register and carbon copy is dispatched to forensic medical practitioner who has requested the examination. In case of a tumor, an

additional copy of the report is prepared and sent to Provincial Director, Tumor Registry.

Steam distillation is a method for separating volatile organic substances, which are insoluble in water from nonvolatile impurities. It is applied to those compounds, which have an appreciable vapor tension at boiling point of water. Steps of the procedure:

- Weigh the material
- Mince it finely
- Mix with water 3-5 times its volume
- Acidify with non-volatile acid like tartaric acid
The alkaloids are soluble in water only in the presence of acid
- Subject to steam-distillation, till volatile substances are carried over

Technique is that specimen is placed in a flask and the steam current from a small boiler is passed through it. Flask is set in sloping position and heated over a water bath. Substance present in the specimen evaporates and goes along with the steam in a water condenser where it gets collected in the receiver. Distillate so prepared is transferred to a separating funnel, in which the liquid, which is not miscible with water gradually, forms a separate layer. It can now be removed easily and subjected to specific further tests for identification of various volatile substances such as alcohol, cyanide, phenol etc. (Fig 17.6)

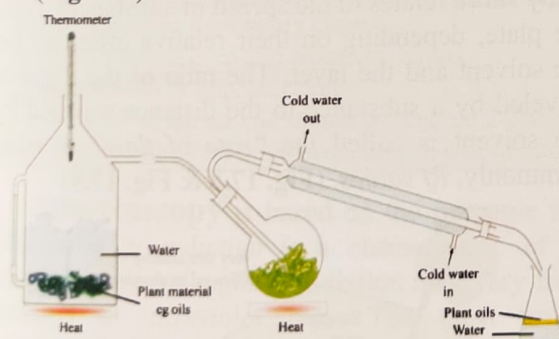


Fig 17.6: steam distillation apparatus

Micro-diffusion analysis is a rapid method of isolation and detection of volatile poisons and gases including acetaldehyde, carbon monoxide, cyanide, ethanol, methanol, fluoride and halogenated hydrocarbons. A simple micro-diffusion apparatus consists of a small porcelain dish having two compartments, a central well surrounded by a peripheral well and a ground glass cover-plate. The outer wall of the peripheral well is slightly higher than the partition wall. Samples such as blood, urine or tissue homogenate is placed in the

outer well and color reagent, which is either an absorbent or solvent, is placed in the inner well. Dish is covered with cover-plate and sealed with an inert viscous material. Volatile poison on gently heating the dish will diffuse from the sample in the outer well into the atmosphere of the dish and finally will be entrapped by the reagent in the inner well. It produces specific color change in the inner well indicating the type of substance. (Fig.17.7)

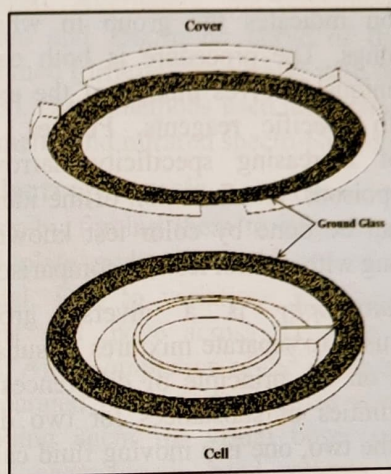


Fig.17.7: Micro Diffusion apparatus

Stas-otto method is based on the principles that the glucosides and alkaloids are soluble in alcohol and thus can be separated from proteins and fats, by alcohol. Glucosides being soluble in solvents like chloroform and ether and alkaloids being readily soluble in water in the presence of small amounts of acid can be extracted from them. Alkalis make the alkaloid insoluble and then with organic solvents one can easily extract them.

Though the test seems simple yet in actual practice it is rather tedious, lengthy and has a definite risk of loss of poison due to so many manipulations. It also requires technical skill. Test involves a series of *filtration* and *extraction*. Material is weighed, minced finely, mixed with two times volume of alcohol and acidified with tartaric acid. This mixture is shaken and passed through many series of filtration and extraction over a long period to get rid of fats and proteins. Residue so left contains organic glucosides and alkaloids. After filtration, it is mixed with an organic solvent like chloroform or ether or their mixture (3:1). Aqueous solution is shaken with organic solvent gently to avoid formation of an emulsion. Shaking is done in a separating funnel. Aqueous solution and chloroform gets separated as chloroform settles down in the lower layer. Chloroform is allowed to evaporate and remaining aqueous solution is made

alkaline to liberate the free alkaloids. Identification of glucosides and alkaloids can now be done with specific tests important being **color reactions, chromatography, ultra-violet spectrometry and Neutron- activation analysis.**

Color reaction method is that technique in which the substance tested for is acted on by a reagent producing an observable color or changing the color of the reagent in a chemical procedure. The reaction indicates the group to which the poison belongs. The procedure is both easy and rapid. Technique involves mixing of the extracted poison with specific reagents. Further, use of reagents of increasing specificity narrows the identity of poisons. Confirmation of the identity of the drug can be done by color test known to be specific along with control test for comparison.

Chromatography is a diverse group of techniques used to separate mixtures of substances. It is based on the principle of differences in the relative affinities of substances for two different media. Of the two, one is a moving fluid called the **mobile phase** and the other, a porous solid or a gel or a liquid coated on a solid support, called the **stationary phase**. A variety of attractive forces between the stationary phase and substances to be separated leads to the selective retardation and redistribution of substances relative to the mobile phase. The attractive forces will in turn depend on solubility and size of the particles. The speed at which each substance is carried along by the mobile phase depends on its solubility in a liquid mobile phase or vapor pressure in a gas mobile phase and on its affinity for the sorbent.

It is a highly sensitive procedure widely used for both qualitative and quantitative detection of drugs such as alkaloids and their metabolites. There are different types depending upon the type of medium used like absorption, affinity, column, gas, gas-liquid, gas-solid, gel filtration, gel permeation, high pressure liquid, ion exchange, liquid, paper and thin layer chromatography.

Thin layer chromatography is most frequently used procedure. A suitable material is required for preparation of a thin layer. It may be silica gel or cellulose powder. Slurry is produced by thoroughly mixing 30g of selected material with 60 ml of water.

Chromate-plate is then prepared by spreading the thick aqueous slurry rapidly and uniformly by a special applicator. Machines are available for

spreading the thin layer. Coated plate is air dried at room temperature for 15 minutes and then in oven at 100- 1100 C for 30 minutes to remove even the last traces of moisture. Optimum thickness is 0.25 mm for routine analytical work. Actual procedure has following steps:

- **Sample application** is spotted over the plate about 2 cm from one end by a micro-pipette or micro-syringe taking care that diffusion of spot over an area more than 2-3 mm does not occur. Solution should be applied in stages, if it is very dilute and spot is dried in a stream of warm air.
- **Sample elution** is undertaken with two plates of identical size, exactly same baseline and exactly same application under same environmental conditions. One plate is developed and sprayed the other plate is developed but not sprayed. The first plate will show presence of spot at particular distance from baseline. In second plate corresponding areas are marked and adsorbent layer from that particular area is removed, that will contain maximum amount of alkaloids. It can be recovered and tested by spectrophotometer.
- **Location of reagent:** The spot can be located and detected after separation and development by spraying the location with chromogenic reagents. They change color with substances indicating their presence and thus facilitating their identification by means of R_f value.

R_f value relates to the spread of substances along the plate, depending on their relative affinities for the solvent and the layer. The ratio of the distance traveled by a substance to the distance traveled by the solvent is called the "**rate of flow**" or more commonly, **R_f values.** (Fig. 17.8 & Fig. 17.9)

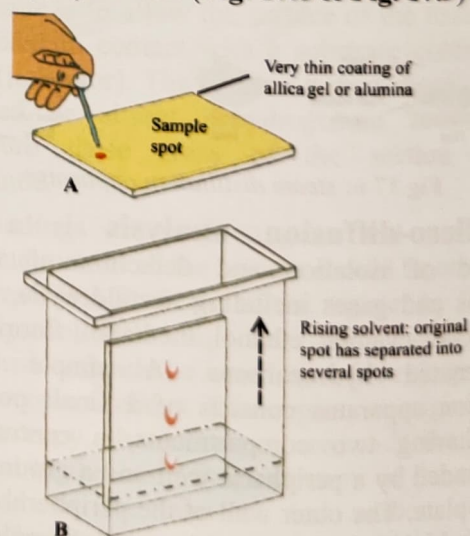


Fig. 17.8: Thin layer chromatography

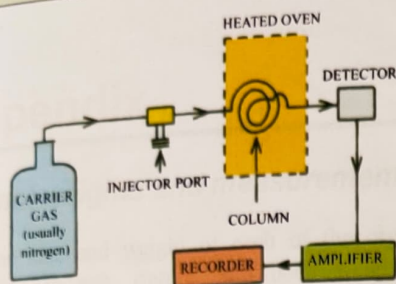


Fig.17.9: Schematic diagram of gas chromatography

A. Liquid sample spotted onto gel-coated plate. B. Plate is placed into a closed chamber that contains rising solvent. Thin layer chromatography has advantages over other procedures with only one limitation that it is difficult to obtain reproducible results without ideal laboratory conditions. The procedure should be undertaken taking essential precautions. (Table 17.5 & Table 17.6)

Table 17.5:

Advantages of thin layer chromatography:

- Economical
- Less time consuming
- Does not involve sophisticated and complicated apparatus
- Highly sensitive (can detect concentrations of 10-20 pg)
- Can withstand the action of most chemicals

Table 17.6:

Precautions for thin layer chromatography

- The plates must be thoroughly clean.
- The slurry must be even and free from lumps.
- The layer should be applied evenly.
- Spot diameter of the sample should not exceed 2-3 mm.
- The plates must be kept dried preferably in a desiccator.

Spectroscopy is based on the principle that absorption of radiation is a characteristic of all molecules. Wavelength of radiation may vary from infrared to ultraviolet rays. The most useful wavelength for toxicological analysis at present is ultraviolet. The interaction between the radiation and a chemical substance depends upon the energy of radiation, which is indicated by wavelength, and structure of the molecule of the substance. The interaction is absorption of light from a source of radiation and then emission of light. (Fig. 17.10)

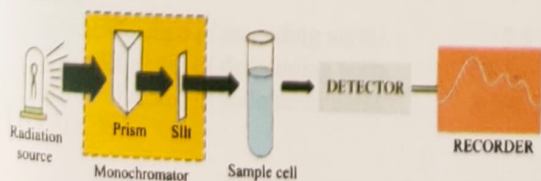


Fig. 17.10: Parts of a simple spectrophotometer

It ranges from visible spectroscopy (traditionally used) for screening hemoglobin derivatives to more sophisticated spectrophotometers, fitted with a sensitive electronics for the detection of the behavior of light. Various methods are available. The amount of light observed by a sample is measured at different wavelengths and from this data an absorption curve is plotted. Alternately, the transmission curve is obtained and absorption curve of the solvent is determined (differential method with different form of rays). Other methods used are ultraviolet spectrophotometry and infrared spectro-photometry.

Electrophoresis separates mixtures of proteins by forcing them to migrate across a gel-coated plate under the influence of an electrical potential. Due to variations in charge and size, proteins will move across the plate at different speeds. After completion of the electrophoresis run, the separated proteins are stained with a suitable developing agent for visual observation. In this manner, characteristic band patterns are obtained that are related to the enzyme type present in the blood. (Fig. 17.11)

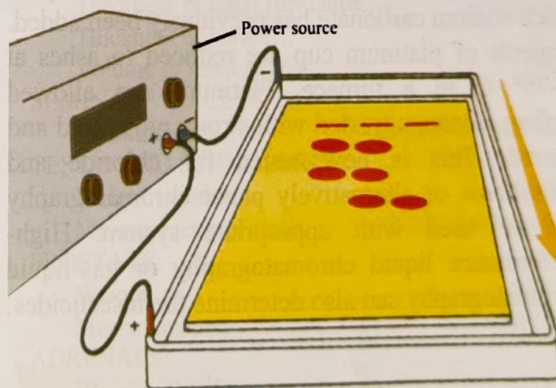


Fig. 17.11: Electrophoresis across a gel -coated plate.

Likewise, mixtures of DNA fragments can be separated by gel electrophoresis by taking advantage of the fact that the rate of movement of DNA, across a gel-coated plate will depend on the molecule's size. Smaller DNA fragments will move at a faster rate along the plate than will the larger DNA fragments.

Radio-activation technique relies on the study of the behavior of the electron around the nucleus. The properties of any nucleus can be studied by making the nucleus unstable. Highly specialized instruments make the nucleus unstable which make it possible to study its properties.

Detection of insecticide compounds has not yet been completely achieved. There are two groups of insecticides, chlorinated hydrocarbons and organophosphates. Former group contains DDT, endrin, diendrin, aldrin, dieldrin, gammaxane where as the later one are melathion, parathion, diaxone, TEPP, HEPP, systoxe.

Many drugs have anti-cholinestrase activity and in the absence of any identifiable drug, an intense anti-cholinestrase activity is indicative of an organo-phosphorous poison. However, there are techniques, which can be applied to test for chloride and phosphorous. The procedure consists of taking 50 gm. of minced viscera preferably liver and fat because insecticides are deposited in fat. The whole contents are covered by hexane. The flask is fitted to reverse condenser and contents are heated on a very low flame. This continuous extraction is carried out for 24-48 hours. Now cool the contents and subject them to frequent washings with distilled water in order to obtain salt-free hexane layer. The hexane is evaporated and contents are then read either in spectrophotometer in appropriate wave lengths along with standard samples of insecticides or the residue is transferred in a platinum cup in which sodium carbonate has previously been added. Contents of platinum cup are reduced to ashes at 65-75° C in a furnace. Platinum cup allowed cooling, contents treated with strong nitric acid and filtered. This is now tested for chloride and phosphorus or alternatively paper chromatography can be used with appropriate system. High-performance liquid chromatography or gas-liquid chromatography can also determine the insecticides.

Appendix

Normal weights and measurements

The size and weight of each of the organs varies according to age, stature, and body weight, but the following figures represent the range of an average normal adult male between 20 and 30 years of age

BRAIN:

Weight...	1250-1440 gm.
Sagittal diameter...	16-17 cm.
Vertical diameter...	12-13 cm.

SPINAL CORD:

Length...	45cm.
Weight...	27-28gm.
Frontal diameters:	
Cervical...	13-14mm.
Thoracic...	10mm.
Lumbar ...	12mm.
Sagittal diameters:	
Cervical...	9mm.
Thoracic...	8mm.
Lumbar...	9mm.

PITUITARY:

Weight...	610mg
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PINEAL:

Weight...	140-170gm.
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PAROTID GLAND:

Weight...	about 30 gm.
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SUBMAXILLARY GLAND:

Weight...	about 17 gm.
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THYMUS:

Weight...	19-23 gm.
-----------	-----------

HEART:

Weight...	275-325 gm.
Thickness of auricles....	1-2 mm.
Thickness of left ventricle...	8-10mm.
Thickness of right ventricle...	2-3mm.
Circumference of mitral ring....	10 cm.
Circumference of aortic ring...	7.5 cm.
Circumference of pulmonic ring....	8.5mm.
Circumference of tricuspid ring...	12 cm.

PULMONARY ARTERY:

Circumference....	8 cm.
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AORTA:

Circumference of ascending aorta...	7.5 cm.
Circumference of descending aorta...	4.5-6 cm.
Circumference of abdominal aorta...	3.5-4.5 cm.

THYROID:

The size and weight of the thyroid varies geographically, but the normal thyroid should not exceed 40gm.

Measurements.

1.5-2.5 × 3-4 × 4-7 cm.

PARATHYROID:

Weight....

115-130 gm. For 4

LUNGS:

Weight of right lung...

375-550 gm.

Weight of left lung...

325-450 gm.

LIVER:

Weight...

1500-1700 gm.

Measurements...

25-30 × 19-21 × 6-9 cm.

SPLEEN:

Weight....

125-175 gm.

Measurements...

3-4 × 8-9 × 12-14 cm.

PANCREAS:

Weight...

90-120 gm.

Measurements...

3.8 × 4.5 × 23 cm.

KIDNEYS:

Weight of each....

140-160 gm.

Measurements...

3-4 × 5-6 × 11-12 cm.

Thickness of renal substance...

20-23 mm.

Thickness of cortex...

6-7 mm.

Volume of renal pelvis...

10-15 cc

SEMINAL VESICLES:

Measurements...

0.9 × 1.6-1.8 × 4.1-4.5 cm.

TESTIS AND EPIDIDYMUS:

Weight together...

17-27 gm.

Measurements of testis.

2-2.7 × 2.5-3.5 × 4-5 cm.

PROSTATE:

Weight...

14-16 gm.

Measurements...

2.7 × 3.6 × 1.9 cm.

ADRENALS:

Weight of each...

5-7 gm.

Measurements...

0.5 × 2.5-3.5 × 4-5 cm.

GASTROINTESTINAL TRACT:

Length of esophagus, cricoid to cardia.

25 cm.

Vertical length of stomach..

25.30 cm.

Length of duodenum...

30 cm.

Length of small intestine.

550-560 cm.

Length of large intestine.

150-170 cm.

UTERUS:

Weight in nullipara...

40-60 gm.

Weight after a pregnancy..

75-125 gm.

OVARIES:

Weight of one...

8-12 gm.

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